SCIENCE ABSTRACTS.

Section A.—PHYSICS

DECEMBER 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1912.

GENERAL PHYSICS.

1791. *Orthostathmescope for Measuring Astronomical Positions.* **Claude and Driencourt.** (Comptes Rendus, 155. pp. 574–577, Sept. 23, 1912.)—In the determination of astronomical positions a method capable of giving considerable accuracy consists in the measurement of the instant when two stars have a difference of azimuth equal to zero or 180°. Hitherto there has been no instrument adapted to this class of observation, and in the article the author outlines the general design of the requirements. The observation actually consists in noting the passage through the zenith of the alignment joining two selected stars. The proposed instrument consists of a telescope, part of whose objective is directed to one star, while light from another is reflected into it by an adjustable mirror. A cylindrical mirror is attached to the plane one, for level adjustment by means of a mercury bath. C. P. B.

1792. *Thermal Phenomena in India-rubber.* **A. Schwartz** and **P. Kemp.** (Le Caoutchouc et la Gutta-percha. Abstracts in Municipal School of Technology, Manchester, Journ. vol. 5. Mech. Eng. 30. p. 257, Aug. 30, 1912.)—Rubber when stretched in the cold shows first slight cooling and then, as the stress is increased, heating. This was noticed by Joule and by Chauveau; the latter ascribed the phenomena to two effects: a displacement of the position of the molecular groups relatively to their positions of equilibrium, and a change in the dimensions of the intermolecular spaces. This view does not explain why the two effects are only observed when the experiments are made in the cold, and it is suggested that two or more types of molecular aggregation exist. The temperature effects are considered after Schmulewitch. H. B.

1793. *Internal Friction of Solids: Variation with Temperature.* **C. E. Guye.** (Journ. de Physique, 2. Ser. 5. pp. 620–645, Aug., 1912.)—Torsional oscillations of a wire undergo damping even when the support is rigid and of considerable mass, and the vibrating system is contained in an evacuated chamber. To the totality of the causes producing this damping is given the name "internal friction." The present paper describes experiments on wires of different materials with the object of determining how the internal friction depends on temperature. Various considerations lead to the conclusion that the properties of a solid depend not only on its apparent chemical composition and on the conditions of temperature and pressure at the moment considered, but also on its previous thermal or mechanical history. Hence all wires used were treated (by prolonged heating) until, as shown by photomicrographs, no difference of structure could be detected between the outer layers and the centre, the load carried by the wire in the torsional experiments being attached before the annealing process was started. The upper part of the case containing the wire and load could be electrically heated to over 400° C., temperatures being measured with Pt-resistance thermometers, and the case was evacuated as much as possible. Only vibrations of small amplitude were used throughout. After annealing for from 6 to 12 hours, experiments were made with temperatures decreasing to the ordinary temperature and then for increasing temperatures. The values of the logarithmic decrement λ were sensibly the same for both falling and rising temperatures, so that there is no appreciable thermal hysteresis. The wires dealt with were of Pt, steel, Au, Ag, and Cu, and all show considerable variations of λ with temperature; *e.g.* Cu from 19° to 308° C. shows a variation of λ from 0·001 to 0·173. There is also, particularly at high temperatures, a considerable variation of λ with the load carried by the wire. The duration of oscillation, in experiments with the same wire, only varied slightly with the temperature. Variation of the inertia, other conditions being the same, gave practically constant values for λ with the two wires tested (Ag and Cu). The results for the steel wire show that it may be possible, by studying the damping, to fix the transformation points, if such exist, for the material of a wire. λ for steel reaches a maximum about 180° C. and then a minimum about 220° C., and steel is known to have a transformation point about 200° C. Results obtained at temperatures down to that of liquid air confirm generally the results for higher temperatures. For all the metals tested, with the exception of Au, which shows a minimum for λ of about —40° C., λ has its lowest value for the lowest temperature used. In all experiments it was found that λ varied linearly with the (small) amplitude, and generally λ is more affected by the amplitude the higher the temperature; but this is not always the case. The latter part of the paper discusses some hypotheses of the nature of internal friction. Among other things it is suggested that since, as Bouasse found, magnetism has a decided influence on the internal friction of iron wires, not only the phenomena of molecular agitation, but also those of molecular orientation, which essentially characterise magnetism, ought to be considered in the explanation of internal friction. A. W.

1794. *Factors in Repeated Stress Tests.* **J. B. Kommers.** (Eng. Record, 66. p. 331, Sept. 21, 1912. From paper read before the Congress of the Internat. Assoc. for Testing Materials.)—Using a Landgraf-Turner alternating impact machine [Abstract No. 1348 (1909)] the factors affecting the results of repeated and alternating stress tests have been investigated. While the amount of deflection has a great effect on the total number of cycles previous to rupture, the speed has little or no effect. Impact has little or no effect, but the condition of the surface of the specimen has a very important effect. The character of the fracture bears an intimate relationship with the total number of reversals. All the specimens giving high results break with fine fractures, while specimens giving poor results break with coarse fractures. F. C. A. H. L.

1795. *New Method of Testing Welds.* **C. Frémont.** (Eng. Record, 66. p. 338, Sept. 21, 1912. From paper read at the Congress of the Internat. Assoc. for Testing Materials.)—Impact tests have been carried out on un-nicked specimens (8 × 10 mm. in cross-section) of scarf-jointed welds of steel to steel, steel to iron, and iron to iron made by capable smiths, with the object of determining the limits between which the strength is likely to vary. Macrographic examination of etched welds revealed sharp lines of demarcation in each case. Whilst the original steel had an impact resistance of 50 kg.-metres and the iron of 26 to 32 kg.-metres, many of the welds broke below 1 kg.-metre owing to the weld opening. The steel-to-steel welds gave the best results, but the resistance was never more than 15 or 16 kg.-metres. Autogenous welds are weaker still, because of lack of continuity in the added metal and of lack of hammering.

F. C. A. H. L.

1796. *New Method of Testing Rivet Steels.* **C. Frémont.** (Eng. Record, 66. p. 266, Sept. 7, 1912.)—In the design of riveted members it is customary to allow only for the shearing strength of the rivets, while in practice it is essential that slipping should be resisted solely by the adhesion of the plates, since if the rivets alone are relied upon they would undergo gradual shearing, eventually failing. The new method of test is to determine the resistance of two plates to rotary slip about the rivet as an axis. The wide variation in roughness of unmachined plates rendered the results obtained useless for analysis, so it was necessary to use machined plates. The figures obtained are therefore not directly applicable to practice, but furnish figures of relative merit of the rivet steels, since the apparatus used ensures uniform conditions of drilling and riveting. It is pointed out that the conditions of riveting should be made less favourable than those occurring in practice. E. J. S.

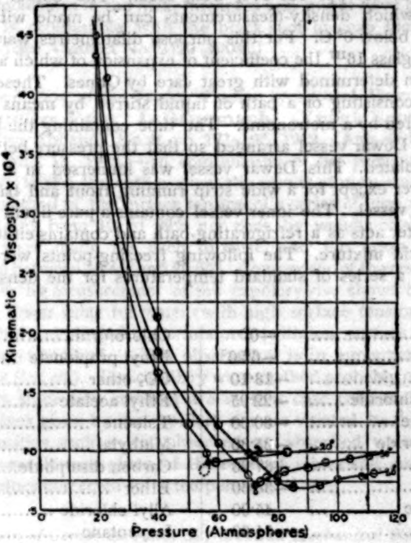
1797. *Changes in the Properties of Metals brought about by Working.* **G. Tammann.** (Zeitschr. Elektrochem. 18. pp. 584–598; Discussion, pp. 599–601, July 15, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—The changes in the properties of metals brought about by working have been ascribed to the conversion of the originally soft crystalline material into a hard amorphous variety; but such conclusions are unsound because they are not in accordance with the equilibrium diagrams, they cannot be justified thermodynamically, and, further, they are not compatible with the fact that the elementary portions of a metal are of the same sclerometric hardness before and after deformation. Below the elastic limit, deformation of a crystal is homogeneous, but above this point simple translation or a more complicated displacement accompanied by twinning takes place along certain gliding planes. The conditions of plasticity in a metal are that there must be at least three series of slip surfaces, and that the strength of the crystal element must be very high in comparison with the forces causing slip. The greater the number of slip-planes produced, the greater is the plasticity of the crystal. A relatively small force acting for a long time is more favourable to deformation than a large force acting suddenly. The tendency to form slip-bands is determined by the temperature, hydrostatic pressure, and the impurities present. In a plastic crystalline conglomerate there is a great difference between the force required to produce the initial deformation (lower elastic limit) and that at which general flowing takes place (upper elastic limit). The greater the number of slip-planes per unit of volume on which displacement can

occur, the higher is the elastic limit and the greater the amount of work which has been put on the metal. Grain size has a great influence on the elastic limit, metal with a small grain-size having a relatively high lower elastic limit. This accounts for the relatively high elastic limit of eutectics. With regard to the recrystallisation of cold-worked metals, it is found that at any temperature the velocity of recrystallisation is proportional to the square of the number of slipping surfaces. If this crystallisation were brought about by the formation of a new phase its velocity would be the same at any particular temperature for any degree of working. Working slightly decreases the density, the effect of drawing into wire being to diminish the density of copper by 0·01 % and iron by 0·25 %. This difference is probably accounted for by the fact that in the deformation of iron twinning takes place and forms hollow channels. It is noticeable that hydrostatic pressures even up to 10,000 atmos., do not affect the properties of metals, since no deformation is brought about. The energy-content of metals is increased on deformation consequent upon the absorption of work by the formation of slip-planes. About 5 to 15 per cent. of the total work done is rendered latent and the increase of energy-content is proportional to the increase in strength of the metal. Deformation increases the specific heat of a metal. Similar effects are obtained by diminishing the grain-size—a fact which is specially noticeable in eutectics. Electrical conductivity and magnetic permeability are diminished, whilst hysteresis and coercive force are increased, by working.
F. C. A. H. L.

1798. *Electrical Measurement of Wind Velocity.* **J. T. Morris.** (Electrician, 69. pp. 1056–1059, Oct. 4, 1912. Abstract of paper read before the British Assoc. at Dundee.)—Describes a method of measuring wind velocity in which an electrically-heated wire is kept at a constant temperature when exposed to a current of air. The square of the power required to keep constant the temperature elevation is nearly proportional to the velocity of the air current. Several different electrical arrangements were employed; these are described in detail and compared. Platinum wires were found most suitable, though possibly electrolytic nickel would be quite satisfactory if it were readily obtainable. Curves are reproduced illustrating the results obtained. [Compare Bordoni, Abstract No. 1815 (1912).] A. W.

1799. *Resistance to Flow of Water along Capillary Soda-glass Tubes at Low Rates of Shear.* **A. Griffiths** and **C. H. Knowles.** (Phys. Soc., Proc. 24. pp. 350–357, Aug., 1912.)—The apparent increase in viscosity of ordinary distilled water, found by Duff [Abstract No. 1333 (1905)] to occur with water stored in soda-glass tubes, is attributed to organic growths in the water, as the authors find that while with ordinary distilled water they obtain such growths, with consequent increase in the viscosity, if the water is sterilised by addition of a trace of copper nitrate, no increase in viscosity occurs. With a max. rate of shear of one radian per sec., the mean apparent value of the coefficient of viscosity obtained at an average temperature of 16·68° C. is 0·01089. W. H. St.

1800. *Viscosity of Carbon Dioxide.* **P. Phillips.** (Roy. Soc., Proc. Ser. A. 87. pp. 48–61, July 26, 1912.)—Measurements were made of the viscosity of carbon dioxide at 20°, 30°, 32°, 35°, and 40° C. under pressures ranging from 1 to 120 atmos. The results are shown graphically in the Fig. Since the viscosity of a liquid decreases, whilst that of a gas increases, with rising temperature, the curves are bound to intersect if produced, but should probably form parts of a continuous curve represented by an equation of the van der Waals type. If viscosity and density are plotted against one another the observations for all the different temperatures lie upon a single curve, the viscosity being thus determined almost wholly by the large changes of density and scarcely at all by the small changes of temperature now under consideration. From density 0·2 to 0·7 the viscosity is a linear function of the square of the density. In this region, therefore, the change in viscosity is due almost entirely to the change in attraction between adjacent layers of the fluid, as represented by the factor a/V^2 of van der Waals' equation. At higher densities it is probable that the alteration in kinetic energy of the molecule begins to play a large part, whereas at low densities the attraction between the molecules becomes negligible. T. M. L.



1801. *Flow of Oil in Tubes.* **S. D. Carothers.** (Roy. Soc., Proc. Ser. A. 87. pp. 154–168, Aug. 21, 1912.)—Describes experiments on the flow of Texas oil through pipes of 2, 2·875, 3·125, 6 and 10 in. diam. respectively. The experiments were carried out at Portland. The oil, contained in a tank of 2000 galls. capacity, could be steam-heated to any required temperature; it was allowed to flow through the pipe line used from the storage tank on the hillside to tank steamers in the harbour, under a constant head. All results are plotted, and from the diagrams it is seen that the only cases in which two distinct branches occur are in two sets of experiments on the 6-in. pipe. The values of the critical constants in these cases are almost identical with that obtained by Orr on theoretical grounds [see Roy. Irish Acad., Proc. 27. A. Nos. 2 and 3, 1907]. The formula $(\bar{v})^{1\cdot5} = C_2 D^{1\cdot2} H . /(\mu_R^{0\cdot75} . L)$

applicable to velocities within the range of the experiments above the critical point can only be regarded as perhaps the best mean result. Other relations can be found which fit the greater portion of the experiments very fairly. The value of log C_3 was found to be about 3·33, but considerable variations from this value occurred. A. W.

1802. *Density of Liquids below* 0°. **J. Timmermans.** (Roy. Dublin Soc., Proc. 13. 25. pp. 310–374, Oct., 1912.)—The author has described methods by which density-measurements can be made within 1/10000 at temperatures below 0° C. For this purpose dilatometres were used of Jena thermometer-glass 16^{III}, the coefficient of expansion of which at low temperatures has been determined with great care by Onnes. These were inserted in a cryostat consisting of a bath of liquid stirred by means of an electromagnet operated by a metronome. The tube containing the bath fitted into an unsilvered Dewar vessel arranged so that the pressure between the walls could be regulated. This Dewar vessel was immersed in a second vessel, silvered all over except for a wide strip running front and back from top to bottom of the vessel. The inner vessel contains a pure liquid at its freezing-point: the outer acts as a refrigerating-bath and contains either liquid air or a carbonic acid mixture. The following freezing-points were determined, and provided a series of standard temperatures for the density determinations:—

Ice	—0°	Chloroform	—63·30°
Aniline	—6·20°	Ethyl propionate	—74·25
Benzonitrile	—13·10	CO_2-ether	—78·35
Carbon tetrachloride	—22·95	Ethyl acetate	—83·40
Bromobenzene	—30·60	Toluene	—94·50
Ethylene chloride	—35·30	Methylal	—104·85
Anisol	—37·20	Carbon disulphide	—111·60
Mercury	—38·60	Ether	—123·30
Chlorobenzene	—45·00	Allyl chloride	—136·40
Metaxylene	—54·60	Isopentane	—158·05

In the case of 12 liquids (chlorobenzene, acetonitrile, isobutyric acid, pyridine, chloroform, ethyl acetate, acetone, toluene, methyl alcohol, ether, pentane, and isopentane), the coefficient of expansion was determined within 1 part in 1000 over the range from 0° to the freezing-point of the liquid.

The following theoretical conclusions were reached: (1) The law of the rectilinear diameter never holds good rigorously for determinations far from the critical temperature, *e.g.* in the case of normal pentane the rectilinear diameter observed from the critical point (197° C.) to 0° curves sharply between 0° and the freezing-point (— 130°). (2) With the exception of water and helium the phenomenon of max. density is never observed even in the case of liquids which are notoriously polymerised. (3) The law of corresponding states, as modified by Mme. K. Meyer, holds good to the lowest temperatures. (4) The ratio of the max. density to the critical density is equal to the ratio of the critical density to the theoretical density. The work is being extended in the case of those liquids which promise to be serviceable in the construction of precision thermometers for use at low temperatures. T. M. L.

1803. *Oil Films on Water.* **H. Devaux.** (Journ. de Physique, 2. Ser. 5. pp. 699–719, Sept., 1912. Paper read before the Soc. franç. de Physique, April 19, 1912.)—Describes experiments on films of oil in equilibrium on water of which the following are the chief conclusions:—(1) The equilibrium layer of oil on water is a very thin continuous layer. (2) The thickness of this oil film varies between the limits 1·10 $\mu\mu$ and 2 to 3 $\mu\mu$. (3) In some cases the film was composed of a single layer of molecules, since their theoretical diam. is 1·13 $\mu\mu$. (4) In cases where the oil presented globules in equilibrium with a continuous layer, the layer probably had not more than two molecules in the max. thickness and might have had less. (5) This thickness is comparable with the black spot in soap films (6 $\mu\mu$) but is still weaker. [See Abstract No. 2129 (1904).] E. H. B.

1804. *Determination of the Surface Tension of Alcohol-Water Mixtures by the Method of Capillary Waves.* **L. Grunmach.** (Kaiserl. Normal-Eichungs Kommission, Wiss. Abhandl. No. 8. pp. 171–196, 1912. Ann. d. Physik, 38. 5. pp. 1018–1026, Aug. 13, 1912.)—In continuation of his previous work [see Abstract No. 736 (1909)], the author gives the results of measurements by the capillary wave method of the surface tension of a series of nine alcohol-water mixtures containing from 10 to 89·8 per cent. by weight of alcohol. Five measurements were made for each mixture, and the mean temperature employed varied between 18·44° and 20·54°. Comparison of the results obtained with those given by measurement of the capillary rise shows that the latter method gives a lower value for water (with high surface tension) and higher values for alcohol and alcohol-water mixtures (with low surface tension) than the capillary wave method. This observation is in agreement with those previously made (*loc. cit.*). The capillary wave method probably gives the more accurate results, since new surfaces are in that case continually produced, whereas the values given by the capillary rise are vitiated by the influence of traces of impurities such as fat, absorbed air, absorbed water-vapour, etc. The numerical results are given in the form of tables and also of a curve, showing the values corrected for a temperature of 20°. T. H. P.

1805. *Tension of Composite Fluid Surfaces and Mechanical Stability of Films of Fluid.* **W. B. Hardy.** (Roy. Soc., Proc. Ser. A. 86. pp. 610–635, July 20, 1912.)—In order to gain further information as to the variations of surface energy with variations in the thickness of a film, the tension of mechanical stability for surfaces of water on which a known impurity was allowed to spread was investigated. It was found that the effect of the impurity depended upon its chemical nature. Substances of great chemical stability such as the higher paraffins, refuse to spread at all, and only lower slightly the tension of water. Esters—such as glycerides—produce a great fall of tension, and an exceedingly thin film of the order of 2 $\mu\mu$ thick suffices. It is suggested that the great activity of esters is due to their being partially decomposed at the interface with the production of a contact difference of potential between the film and the water. T. M. L.

1806. *Relativity and Gravitation.* **M. Abraham.** (Ann. d. Physik, 38. 5. pp. 1056–1058, Aug. 13, 1912.)—The author points out that by admitting an influence of gravitation on the velocity of light, Einstein [Abstract No. 1468 (1911)] abandoned the second postulate of his own relativity theory, which assumes the constancy of the velocity of light; and, further, that by abandoning the invariance of the equations of motion during Lorentz transformations [Abstract No. 1321 (1912)], the whole theory is brought to the ground. If among all systems of co-ordinates that system is singular in which the gravitational field is static, or quadri-static, we may call a motion referred to this system an "absolute" motion. According to the old distance-action theories the system of co-ordinates was fixed by the positions of distance stars, or perhaps Neumann's "body α." This point of view is strange to the modern field-action hypothesis, but adherents of the latter need not object to refer absolute motions of bodies to an omnipresent gravitational field. Einstein uses a Henristic hypothesis which he calls the "principle of equivalence," and which postulates a space-and-time correspondence of two relatively accelerated systems. But the author doubts if a relativistic system can be successfully based upon this new foundation. E. E. F.

1807. *Penetrability of Atoms.* **C. Ramsauer.** (Jahrbuch d. Radioakt. 9. pp. 515–538, Sept., 1912.)—Geiger's curve [Abstract No. 850 (1911)] giving the connection between the secondary radiation and the length of path (and speed) of α-rays may be found quantitatively from the corresponding curve for β-rays. Hence it is concluded that secondary radiation in gases by moving electrons and moving atoms is essentially the same, and is bound up with the penetration of the ionised atom in both cases. Moving atoms act not only by penetration but by close approach. At speeds above 10^9 cm./sec. every impact produces penetration, while below 2×10^8 cm./sec. all penetration ceases. Between these two values there is a region of transition in which the former state of things gives way before the latter, slowly at first, and then more and more rapidly. Below 2×10^8 cm./sec. the analogy between moving atoms and moving electrons ceases. J. J. Thomson's formula for the generation of secondary rays by α-rays does not agree sufficiently with observed values to regard the effect as due to anything else than a moving system of electrons. To cover all observations, Thomson's formula for kathode rays must be combined with Lenard's conception of the impenetrability of a portion of the atom, a portion whose magnitude is a function of the velocity of the electron. E. E. F.

1808. *Nutation and Monorail Car.* **B. L. Newkirk.** (Frank. Inst., Journ. 174. pp. 265–278, Sept., 1912.)—Deals mathematically with the nutation which may occur in the gyroscope of a monorail car on the sudden application of a couple. Numerical cases are also worked out showing, for certain data, a nutational vibration of the car of amplitude half a degree for *sudden* application of couple, or an amplitude of a twentieth of a degree when the couple grows uniformly at a specified rate. [See Abstract No. 1484 (1912).] E. H. B.

1809. *Pendulum Determinations of Gravity.* **A. Berget.** (Comptes Rendus, 155. pp. 557–560, Sept. 16, 1912.)—For relative determinations of the value of gravity the author has devised an electrically-maintained pendulum, in which, as the impulses are given precisely at the centre of the swing, the rate of vibration is dependent only on the value of "*g*." The pendulum can register each oscillation on a chronograph, and its beats are also counted on a dial. Two auxiliary pens on the chronograph are used respectively for recording the passage of a star on successive days across the seven wires of a transit instrument and for recording the completion of each 86,400th beat of the pendulum. It is therefore only necessary to run the chronograph for a few minutes each day, and there is no need for the usual comparison pendulum. A. D. R.

1810. *Comparison of Screws.* **C. Barus.** (Amer. Journ. Sci. 34. pp. 333–337, Oct., 1912. Abstract from report to the Carnegie Inst. of Washington.) P. E. S.

1811. *Gyroscope.* **F. Slate.** (Phys. Rev. 35. pp. 86–94, Aug., 1912.)—Discusses mathematically some aspects of the dynamics of the gyroscope, with references to Euler, to Routh, and to Klein and Sommerfeld. E. H. B.

1812. *Relativity Transformation Equations.* **A. C. van R. van Alkemade.** (Ann. d. Physik, 38. 5. pp. 1033–1040, Aug. 13, 1912.)—A mathematical discussion of the views recently put forward by P. Frank and H. Rothe [see Abstracts Nos. 2277 (1905) and 990 (1911).] E. H. B.

1813. *Relativity Theory.* **J. Ishiwara.** (Jahrbuch d. Radioakt. 9. pp. 560–648, Sept., 1912.)—A serious *résumé* of the whole subject with a bibliography extending over nine pages. [See Abstract No. 525 (1912).] E. H. B.

1814. *Daily Changes in Temperature up to 4000 Metres.* **A. J. Henry.** (Mount Weather Observatory, Bull. 5. pp. 1–18, 1912.)—The paper deals with the changes in the temperature of the free atmosphere which occur from one day to the next, and is in continuation of a previous paper [see Abstract No. 997 (1912)] which dealt with similar changes occurring at the mountain summits and valley bottoms in the neighbourhood of Mount Weather Observatory. The upper-air observations have been made by means of kites. The author points out that owing to the observations not being made at the same hour on consecutive days some difficulty is introduced by the normal diurnal range of temperature which would be combined with the non-periodic changes in the measurements made. This source of error has been allowed for as far as possible. Tables are given showing all cases in which the temperature-change amounted to 2° C. or more in 24 hours, the days being separated into groups for winter and summer and for "temperature rising" and "temperature falling." From these tables it is found that the magnitude of the changes is less in summer than in winter, and that the changes from day to day are greater for falling than for rising temperature. It is also found that the max. change occurs at from 1 to 2 km. height above sea-level and not at the earth's surface. Various possible causes of these changes are reviewed, and it is concluded that the importation of air horizontally from regions of higher or lower temperature is the predominating one. A specially pronounced fall of temperature which occurred on December 27–28, 1911, is dealt with in detail. In order to show the distribution of pressure associated with the most pronounced changes of temperature, maps are reproduced showing the positions of the neighbouring high- and low-pressure centres for the days dealt with in the previous tables. The conclusion is reached, that for rising temperature in the free air above Mount Weather the centre of high pressure is to the east and of low pressure to the west of the station, whereas for falling temperature the positions are reversed. J. S. Di.

1815. *Aerial Currents in West Africa.* **H. Hubert.** (Comptes Rendus, 155. pp. 627–629, Sept. 30, 1912.)—Observations made at Dakar near Cape Verde and neighbouring places in West Africa lead the author to the opinion that the "harmattan," or dry and hot E. or NE. wind experienced there, is part of the general circulation of the atmosphere, and not merely a local wind. At Dakar itself the trade-wind from the north is experienced during eight months of the year. Towards Feb. or March the harmattan occasionally breaks in as a hot, dry wind from the east. Farther inland the harmattan blows constantly throughout the winter. It seems probable that the latter wind passes over the former as the sea is approached, but owing to the absence of clouds in winter the supposition has not been verified. In June, however, alto-cumulus clouds are seen to move to the west, while the northerly trade blows at the surface, showing the existence of the harmattan above the relatively cold and damp trade-wind at that time. The trade-wind and the harmattan are, therefore, probably distinct currents, the latter forming the return branch of the Atlantic air circulation. R. C.

1816. *Geochemical Statistics.* **F. W. Clarke.** (Amer. Philosoph. Soc., Proc. 51. pp. 214–234, July, 1912.)—From the surface of the United States the rivers annually carry to the sea 270 million tons of dissolved substances, and 513 million tons in suspension. If this holds universally, the quantity deposited in the ocean during geologic time should be 102×10^{15} tons, and the total sedimentation becomes 156×10^{15} tons. This quantity, distributed over the entire sedimentary area, continental and oceanic, gives an average thickness of about 550 ft., or 79×10^{-6} in. a year. The total volume of the marine sediments thus computed is 14 million cubic miles, of which 9 million remain in the ocean. The volume of all the secondary rocks derived from the decomposition of igneous rocks was previously found to be 78 million cubic miles. Hence the portion now on the land area of the globe amounts to 69 million cubic miles of rock, consisting in great part of materials which were never transported very far from their original place of formation. To the oceanic deposits must be added large quantities of dust and volcanic ejectamenta, but the major portion of these must come from disintegrated sedimentary rocks, sands, and soils. E. E. F.

1817. *Temperature in the Interior of a Mountain.* **V. Volterra.** (N. Cimento, 4. Ser. 6. pp. 111–126, Aug., 1912.)—After referring to the principal determinations which have been made of the geothermal degree—or depth of earth between points differing in temperature by 1 deg. C.—from the results of which the normal figure appears to be 36·37 m., the author describes how Thoma applies Fourier's theorem to determine the temperature inside a mountain at a known depth from the surface, and a known distance laterally from a given point, the conductivity, specific heat, and density of the mountain, considered uniform, being also known. The temperatures deduced in this way for the St. Gothard tunnel agree fairly closely with those actually observed, and the importance of the subject in tunnel-boring is pointed out. W. H. Sı.

1818. *Seismic Waves and the Earth's Interior.* **L. Geiger** and **B. Gutenberg.** (Gesell. Wiss. Gottingen, Nachr., Math-phys. Klasse, 6. pp. 623–675, 1912.)—This paper is an account of a continuation of previously published work [see Abstract No. 1004 (1912)]. A study of the transverse earthquake waves arriving from epicentres at distances of 63° to 82° shows that in these waves the vibrations are in the plane passing through the seismic epicentre, the centre of the earth and the observing station. Further, by measurement of the relative intensities of the longitudinal and transverse waves, the authors have been able to improve on the Wiechert-Zoeppritz propagation-time curves for these preliminary tremors and for their chief reflections. The hypothesis of three surfaces of discontinuity in the material of the terrestrial globe—which the authors previously put forward as a result of their study of the longitudinal waves—is now supported by the results drawn from the observations of the transverse waves. The following table gives the depths in km. of these surfaces, and the speeds, V_1 and V_2 (in km. per sec.), of the first and second phase waves, and μ the value of Poisson's ratio at these depths :—

Depth.	V_1.	V_2.	μ.
0	7·174	4·010	0·272
1193 ± 50	11·80	6·59	0·273
1712 ± 100	12·22	6·86	0·270
2454 ± 100	13·29	7·32	0·282

A. D. R.

1819. *Volcanic Flashing Arcs.* **F. A. Perret.** (Amer. Journ. Sci. 34. pp. 329–338, Oct., 1912.)—During the eruptions of Vesuvius in 1906, the author observed a succession of bright circular arcs, centred some little distance above the mouth of the crater, which were apparently directly connected with the series of explosions from the volcano. The same phenomena were again seen during the eruption of Etna in 1910. As a tentative explanation they are ascribed to "*visible sound waves,*" the explosions giving rise to condensations and rarefactions sufficiently intense to render visible the strata of air whose refrangibility is altered as the wave proceeds outwards from the crater mouth. C. P. B.

1820. *Seismological Observations at the Island of Pâques.* **de Montessus de Ballore.** (Comptes Rendus, 155. pp. 625–626, Sept 30, 1912.)—Observations made from 1911, April 25, to 1912, May 5, at Mataveri, in the volcanic island of Pâques, in the south-eastern Pacific (1600 miles from the nearest land), showed no earthquakes of local volcanic origin. The centres of the disturbances during the period were mostly at the abrupt declivity bounding the submerged plateau from which the island rises. These facts support the theory that earthquakes are associated rather with slipping of the rocks along steep declivities than with volcanoes. Microseismic disturbances registered by the 100-kg. Borch-Omori pendulum have been proved to be related to the agitation of the ocean. A. D. R.

1821. *Filaments, Alignments, and Solar Protuberances.* **A. Riccò.** (Comptes Rendus, 155. pp. 496–500, Sept. 2, 1912.)—Spectroscopic observations of the solar prominences made for several days in succession at the sun's limb, prove that frequently these phenomena persist during long periods of time. The spectroheliograph, however, gives not only the prominences at the limb, but also on the disc, as is evidenced by the filaments and alignments shown on the beautiful photographs obtained at Meudon under the direction of Deslandres. An attempt was made to utilise the very complete observations made at the Italian observatories by projecting back the positions of prominences at the limb to the areas occupied in various longitudes and latitudes. These drawings are found to resemble very closely the Meudon spectroheliograms. A similar treatment of the results tabulated by Wölfer at Zurich gives closely analogous results. Aggregations of prominences often show round one or other of the sun's poles, just as is seen on the photographs of filaments and alignments. An important conclusion is that there appears to be no definite connection between the non-eruptive prominences and the spots and faculæ. Neither are the filaments and alignments *exactly* the projections of prominences, since the former are absorption images, while the latter are emission images. C. P. B.

1822. *Prominences, Filaments, and Alignments in Upper Solar Atmosphere.* **H. Deslandres.** (Comptes Rendus, 155. pp. 531–538, Sept. 16, 1912. Translated in English Mechanic, 96. pp. 67–68, Nov. 22, 1912.)—Referring to the previous paper by Ricco [see preceding Abstract], it is granted that the three phenomena are closely connected, and various details obtained from close examination of the Meudon photographs are added. Distinguishing between filaments and alignments, the former are generally very black and distinct, and may be considered as a special case of a less black alignment. The filament is usually prolonged to the edge of the sun by an alignment, and the alignments without filaments are longer and more numerous. Filaments are visible on plates taken with calcium and hydrogen light, and are better shown on the latter; in general, the alignments are only discernible on the calcium photographs. Whereas the filaments are usually clearly defined, the alignments may have hazy borders, sometimes fringed by bright streaks, and it is when these cross the solar limb that prominences are often seen. Where this coincides with the intersection or node of two alignments, the prominence there will be unusually large. The filaments show evidence of a comparatively slow ascensional movement of the gas composing them. This feature being also distinctive of those eruptive prominences unconnected with spots. The conclusion of Ricco that spots and filaments, alignments, prominences, etc., show no decided interrelation is not admitted, these different phenomena evidently being components of some organised system of circulation in the solar atmosphere. [**Errata**, Comptes Rendus, 155. p. 666, Oct. 7, 1912.] C. P. B.

1823. *Form of Sun and Moon.* **F. Vlès.** (Comptes Rendus, 155. pp. 545–547, Sept. 16, 1912.)—From a series of kinematograph pictures of the solar eclipse of April, 1912, Costa-Lobo concluded that there was evidence of a slight flattening of the moon's disc perpendicular to its direction of orbital motion. Experimental trial has been made with various geometrical figures, passed in transit with each other, in order to endeavour to imitate the phenomenon of minimum phase-angle of the visible crescent as observed during the eclipse. Although not conclusive, one of the promising results was the passage of an ellipse with long axis parallel to the trajectory over another eclipse with longer axis perpendicular to the motion. It is also interesting to note that, from other considerations, it has been thought that the sun has its polar diameter larger than the equatorial diameter. C. P. B.

1824. *Orbit of Periodic Comet Holmes.* **H. J. Zwiers.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 192–199, Sept. 3, 1912.)—An ephemeris for this periodic comet is given for the period June 15, 1912, to Jan. 1, 1913, with values of the computed brightness. C. P. B.

1825. *Distribution of Stellar Spectral Types.* **Hertzsprung.** (Astronom. Nachr. No. 4600. Nature, 90. p. 115, Sept. 27, 1912. Abstract.)—A table is given showing the distribution in galactic latitude and longitude of seven types of stellar spectra, the data being taken from Harvard Annals, vol. 56, the galactic pole being $\alpha = 190^\circ$; $\delta = +28^\circ$ (1900). It is shown that most of the groups examined lie in a plane almost coincident with the galaxy, some also showing a tendency to congregate into special longitudes. C. P. B.

1826. *Radio-active Elements in Cosmical Systems.* **S. A. Mitchell.** (Astronom. Nachr. No. 4600. Nature, 90. p. 115, Sept. 26, 1912. Abstract.) —The spectra of the sun's atmosphere obtained during the total solar eclipse on Aug. 30, 1905, have been examined carefully for evidence of the occurrence of spectrum lines of radium, emanation, and uranium, as recently suggested by Giebeler and Kayser with regard to the spectrum of Nova Geminorum (which is known to have strongly resembled the chromospheric spectrum). The result was that no evidence of the presence of the radio-active elements was detected. C. P. B.

1827. *Astronomical Refraction near Horizon.* **Arnaud.** (Comptes Rendus, 155. pp. 612-615, Sept. 30, 1912.)—Attention is drawn to a modified formula for computing refractions obtained by certain limiting assumptions with regard to the fundamental formula, which is strictly non-integrable.
C. P. B.

1828. *Studies of Aurora.* **C. Chree.** (Nature, 90. pp. 38-40, Sept. 12, 1912.)—The article is a review of two volumes by Störmer, on the results of an expedition to Bossekop for securing observations of the Northern Lights. Störmer has succeeded in obtaining the first organised series of photographs of the Aurora, many of which are in pairs from separated stations along a measured base line, from which reliable values of the heights of the streamers have been calculated. In one of the volumes under review the details of the expedition are described. From the photographs the calculated heights varied from 36 to 461 km. The second volume is mainly theoretical, dealing with the vicissitudes of an electrified particle supposed to be projected in a uniform magnetic field. One of the great difficulties in applying the usual theory is to account for the occurrence of auroræ in low latitudes; to do this Störmer substituted for the field of a uniformly magnetised sphere that derived from the earth's Gaussian potential, based on the work of Gyllensköld, but found the analytical difficulties increased. Then the experiments of Birkeland showed that kathode rays in a vacuum tube containing a magnetised sphere could form a luminous ring around the equator. Störmer takes this and suggests that the auxiliary magnetic field thus produced may render access to low latitudes possible to other kathode rays coming from the sun. The detailed study of these tabulated auroræ should be especially valuable for comparison with the records of magnetic storms. C. P. B.

LIGHT.

1829. *Doubly-refracting Crystals.* **S. P. Thompson.** (Engineering, 94. p. 550, Oct. 18, 1912. Paper read before the British Assoc. at Dundee.)—A large crystal of Iceland spar is placed on a table which can be turned about a vertical axis, and the crystal is covered by an opaque disc provided with a small hole. On looking through the hole while the light from a glow-lamp enters the crystal, two light-spots (due to the two rays) are seen on the table, and when the table is revolved one spot turns about the other and describes a spiral or an ellipse, changing its level and moving sometimes in a kind of saddle curve. The author explained by diagrams how the phenomenon arose with binocular vision, and stated that the phenomenon was mentioned by Huygens. **Rayleigh** mentioned that Stokes had calculated the lifting (which, as Thompson points out, requires fairly thick crystals for it to become distinct), but not for binocular vision. A. W.

1830. *Rectification of the Spectrum in Relation to the Shift of Ellipses in Displacement Interferometry.* **C. Barus.** (Phil. Mag. 23. pp. 942–955, June, 1912.)—In the author's work of last year the quantity $(\mu - \lambda)d\mu/d\lambda$, where $\mu =$ index of refraction of glass, $\lambda =$ wave-length, occurred in the reductions. It is frequently necessary to find $d\mu/d\lambda$ from a small piece of glass, and a method has therefore been tested in which a Kohlrausch total reflectometer slides along the graduated rail of a modified form of Rowland's grating adjustment. The method, in an altered form, is applicable when a glass grating is given for investigation. It can be applied to the refraction of the material of film gratings. Several experiments are described, and it is concluded "that observations made at angles of incidence 45°, 17°, 78°, have verified the equation $N_e = e \cos R (\mu + 2B/\lambda^2 \cos^2 R)$ from the shift of the centres of the ellipses satisfactorily. To restore the ellipses from one spectrum line to another is equivalent to a motion of the micrometer over $N_e - N'_e = \Delta N_e$. This constitutes a second method of interferometry of lower sensitiveness, *i.e.*, a coarse adjustment on the number of fringes which pass a given spectrum line. Per fringe or per vanishing ring, the displacement of the mirror on the micrometer will be a half wave-length of the part of the spectrum in question." The paper concludes with a reference to the author's new displacement interferometer described in Abstract No. 659 (1912). [See also Abstracts Nos. 485, 1692 (1911).] A. E.

1831. *Interferometry of Air carrying an Electric Current.* **C. Barus.** (Amer. Journ. Sci. 34. pp. 101–106, Aug., 1912.)—The object in view was a direct test as to whether a rarefied column of air, through which a current of electricity is flowing, shows any perceptible change of its index of refraction. The results are negative, but it is intended to repeat the experiments with lower vacuum and higher p.d.'s. The details are published as an illustration of the working of the author's displacement interferometer [see Abstract No. 659 (1912) and preceding Abstract]. A. E.

1832. *Diffraction Rings surrounding the Spectre of the Brocken.* **F. Richarz.** (Meteorolog. Zeitschr. 29. pp. 282–285, June, 1912.)—In a former communication [Abstract No. 592 (1908)] the author described observations of an artificially-produced "spectre of the Brocken" or shadow of the observer on mist, in connection with which he discussed the various explanations of the coloured diffraction rings sometimes seen surrounding the shadow of the head. To account for the rings it seems necessary to assume that a portion of the light which has found its way into the interior of the mist is reflected back, undergoing diffraction among the drops on the way. But since every part of the mist sends light to the observer, confusion would result from overlapping unless a maximum of light is reflected in the direction of the observer, or what is the same thing, in the direction of the source. The author then advanced a new explanation, based on Lambert's law of emission, why the mist as a whole should give max. reflection in the direction of the source, and pointed out the fallacy of the assumption sometimes made that a single drop gives max. reflection towards the source. This former explanation is applicable to two common cases: where the observer is involved in the mist, and where the light falls normally upon a wall of mist. But another case has now become familiar to balloon voyagers, the shadow of the balloon, or car, being thrown by oblique solar rays upon a low-lying cloud surface. The author therefore now gives a more general explanation to include this case also. Light incident on a globule of mist will be reflected at the outer or inner surface, or will pass through as a refracted pencil which, after converging to a close focus, will strongly diverge. Thus the globule, though of transparent material, yet by its action in diverting the rays will act almost like an opaque body in screening other globules in its rear from direct light. A drop in the interior of the cloud can only receive direct light unimpeded when no other drop intervenes between it and the source. Light directly incident upon the surface of an interior drop will be equally reflected in all directions, and if only a single drop were in question the direction of view would be immaterial. But only rays reflected back the way they came can re-emerge freely by a clear path; rays reflected obliquely will find their way blocked by intervening drops. Hence there will be max. reflection in the direction of the source. Diffraction rings can only be produced by a cloud consisting of drops of uniform size; but even when the size of the drops is far from uniform, the maximum of intensity for light reflected by the cloud in the direction of incidence must still exist. Its presence may be masked for an observer in a balloon by the shadow of the car, but several observers have noticed its outer portion as a bright ring bordering the shadow. The commonest forms of diffraction rings met with in meteorological optics are the coronal rings sometimes seen surrounding the sun and moon. The size of the cloud-drops producing the appearance can be calculated from the measured diam. of a ring, and the fact that different rings of the same group give the same value for the drops affords a confirmation of the generally accepted theory of formation of coronal rings. When this simple theory is applied to the rings surrounding the Brocken phenomenon, however, different rings of one group are found to give different values for size of drop, showing that the theory does not hold in this case. The author mentions various circumstances which complicate the question in the case of a reflecting cloud, and may account for the discrepancy. Although light reflected from the cloud in the direction of incidence is of max. intensity, yet the intensity of light emitted in other directions is by no means negligible. Possibly the law of intensity might be obtained from Seeliger's theory of illumination of clouds of dust, as given in his discussion of Saturn's rings. In the theory of lunar coronal rings it may be assumed that the layer of diffracting particles is very thin compared to the distances of source and observer, but this assumption is hardly permissible in the case of the reflecting cloud where some of the particles themselves act as sources of light to others. Further difficulty arises from the fact that light penetrating diffusely-reflecting cloud strata may undergo diffraction both before and after reflection. A. E.

1833. *Photograph taken from a Balloon of an Aureole* (*Glorie*) *surrounding its Shadow.* **A. v. Obermayer.** (Meteorolog. Zeitschr. 29. pp. 286–287, June, 1912.)—[See preceding Abstract.] A description of a photograph published in the Jahrbuch des Deutschen Luftschiffer-Verbandes, 1911, by A. Wegener. It was taken on the maiden voyage of the balloon "Marburg" in very rainy weather in May, 1910. The upper surface of the chief cloud layer lay at 2200 m., but was frequently broken by rising masses. During most of the voyage the balloon was above the clouds and its shadow was frequently seen upon them. At times, but not always, a splendid aureole was also observed, centring about the shadow of the observer's eye. It is noteworthy that it appeared intermittently on the same cloud, indicating that the cloud was sometimes homogeneous and sometimes not, since it is only in homogeneous clouds that similar diffraction phenomena are formed. Measurement of the plate gave for the radii of the three rings visible, after subtracting 16′ for the sun's radius, $\theta_1 = 1^\circ\ 13'$, $\theta_2 = 5^\circ\ 0'$, ($\theta_3 = 8^\circ\ 44'$, very faint). The radius r of the cloud drops can be calculated from θ the radius of an aureole ring by Pernter's formula $r = m\lambda/\pi \sin\theta$, m being a constant depending on the order of the ring. Theoretically all three rings should give the same value of r, but the values of r actually obtained were $r = 0{\cdot}0164$ mm., $r = 0{\cdot}0078$ mm., $r = 0{\cdot}0061$ mm., that is to say the value of r diminished with the order of the ring. A like result has been obtained by several previous observers of the phenomenon, and no satisfactory explanation has as yet been forthcoming. A. E.

1834. *Changes in the Absorption Spectra of "Didymium" Salts.* **W. C. Ball.** (Roy. Soc., Proc. Ser. A. 87. pp. 121–137, Aug. 13, 1912.)—The chief changes produced by dilution of an aqueous solution of didymium nitrate occur when a very concentrated solution is diluted slightly: further dilution, say from 10% to 0·05% Di, produces comparatively small effects, although the salt still alters in electric conductivity. Conditions which would be expected to reduce the ionisation of didymium salts, such as combination with a weaker acid, addition of the sodium or potassium salt of a weak acid, solution in a solvent of less general ionising power than water, or increase of concentration, all produce similar changes in the absorption spectra. T. M. L.

1835. *Changes in Certain Absorption Spectra in Different Solvents.* **T. R. Merton.** (Roy. Soc., Proc. Ser. A. 87. pp. 138–147, Aug. 13, 1912.)—Quantitative measurements of the absorption spectra of uranous chloride in a number of organic solvents showed that the differences cannot be considered as a shift of the bands, since the entire character and intensity of the absorption varies. Evidence has been found in support of the view that the apparent gradual shifts observed when one acid

radical is replaced by another can be explained by the superposition of absorption curves. A marked change in the character of the absorption was found in the presence of free acid, more especially in solvents containing a ketonic group. The addition of another solvent to these solutions causes a slow disappearance of the lines without shift, in accordance with the results of Jones and Strong. The influence of pressure up to 750 atmos. on the absorption spectra of solutions was investigated with negative results. Photographs are given showing the absorption spectra of uranous chloride in ethyl alcohol and acetone, and in acetone, acetophenone and acetonitrile in presence of hydrogen chloride.
T. M. L.

1836. *Lines in Zinc Arc and Spark.* **N. A. Kent.** (Amer. Acad., Proc. 48. No. 5. pp. 91–109, Aug., 1912.)—Describes a study of certain lines in the arc and spark spectra of Zn, an echelon spectroscope being used. The results obtained show that inductance, even in small amounts, produces structure in the spark image. This structure varies with the part of the inductance spark image used, the end showing an enhancement of the intensity of the components lying towards the red. As the inductance is increased the red components in the structure become less intense. A disruptive or non-inductance spark between brass terminals shows structure in the Zn lines studied, and if inductance is inserted the resultant lines are as sharp as or even sharper than those given by a low-current arc. A small amount of vapour in the arc, even with fairly high current (*e.g.* 8 amps.) produces conditions favourable to structure other than the fluting which occurs when the arc is heavily charged with vapour and is noisy. In all the plates upon which the positions of the components of the spark with small inductance are compared with the positions of the components of the arc at low current (about 3·3 amps.) the centre of gravity of the spark structure lies further toward the red than that of the arc. All the observations made, both visual and photographic, confirm the results obtained by Nutting [Abstract No. 704 (1906)] dealing with arc structure. It does not appear possible that the effects observed were due to "ghosts" in the echelon, for the green Hg line showed no false lines.
A. W.

1837. *Spectrographic Study of Tellurium.* **W. L. Dudley** and **E. V. Jones.** (Amer. Chem. Soc., Journ. 34. pp. 995–1014, Aug., 1912.)—The purpose of this investigation was (i) to obtain pure tellurium; (ii) to measure the spectral lines of Te; (iii) to study the effect on the spectrum of fractional precipitation by hydrazine hydrochloride; and (iv) to determine the nature of the final residues. Details are given of the purification and preparation of the Te electrodes, which were fused from precipitated Te in a stream of hydrogen. A large quartz Hilger spectrograph was used. It was found that the lines 3273·4 and 3246·8 recorded by Hartley and Adeney are not present in the spectrum of pure Te and are Cu lines. Six new short wave-length lines are given: 2002·6, 2001·8, 2000·4, 1997·6, 1994·8, and 1993·8; also a table of the wave-length measurements. No evidence of Te being a compound substance was detected, but the authors believe their vigorous treatment of 135 gm. of material would have enabled them to detect a substance such as dvitellurium [see Chem. Soc., Journ. 55. p. 649], which must, if it exists, from its position in the periodic table be considerably different from true Te. Hence they consider Te does not contain the higher homologue of atomic weight about 212, but if not an element, then the only possible alternative is that Te, like Di, may consist of nearly equal parts of substances differing but little in atomic weight and remarkably similar in other properties. The authors' experiments do not negative such a possibility. A. W.

1838. *Arc Spectrum of Mercury.* **G. Wiedmann.** (Ann. d. Physik, 38. 5. pp. 1041–1055, Aug. 13, 1912. Dissertation, Tübingen, July, 1911.)—Describes wave-length measurements in the visible and red parts of the spectrum. A 6·5-m. radius grating was used, and for the faintest lines a Hilger prism spectrograph with great light intensity. Results are tabulated from λ8198 to λ3447·36. It is shown that the lines 6234·5, 5803·7, 5549·5, 5393·7, 5290·3, 5219·1, 5166·0, 5129·1 of the principal series of single lines agree well with the values $m = 5, 6 \ldots 11, 12$ in the Paschen series formula $\nu = (2{\cdot}5S) - (m, P)$, where $(2{\cdot}5S) = 20252{\cdot}4$, $(m, P) = N/[m + P + \Pi\,(m, P)^2]^2$, $P = -0{\cdot}0073064$, $\Pi = +3{\cdot}38595 \times 10^{-6}$. The value $m = 4$ is probably the line 6716·68, but the above formula does not give such good agreement as with the other lines. Parallel with this series is one with the frequency-difference 1577·5. The lines of the principal triplet series and of the first and second subordinate series with their combinations also agree with Paschen's formulæ, and the constants for these are given. [See also Abstracts Nos. 235 (1909) and 245 (1910).] A. W.

1839. *Influence of Density on the Position of Emission and Absorption Lines in a Gas Spectrum.* **G. H. Livens.** (Phil. Mag. 24. pp. 268–298, Aug., 1912.)—In this paper a theory is developed which attributes the changes in position of the lines of a spectrum to density-changes in the actual incandescent vapour. The theory is based on the electron theory of optical effects developed by Lorentz and Drude. The peculiarity of the work here presented consists mathematically in the introduction into the equations of motion of the single typical electron, of a force on that electron due to the polarisation in the surrounding medium. This term is the same as that used by Lorentz in obtaining the law $(\mu^2 - 1)/[\rho(\mu^2 + 2)] = \text{const.}$ connecting the index of refraction (μ) of a simple gaseous substance with its density (ρ). Physically the function of the new term is expressed by saying that the presence of neighbouring electrons causes an increase in the effective inertia of the typical oscillating electron more particularly considered. The paper is in three sections: the first deals with absorption effects, the second with a theory of the emission effects, and the third contains a quantitative comparison of the theoretical and experimental results. It is shown that an absorption line is shifted from its absolute position given by $n = n_0$, the displacement being towards the red end of the spectrum and directly proportional to the density of the gas. It is different for different lines, being proportional to the density of the electrons which give rise to each line. If $n = n_0$ is the natural free period of a group of electrons, N_1 the number of electrons per unit volume with this period as the natural one, e the charge on and m the mass of an electron, a a constant very nearly equal to 1/3, then the centre of an absorption band is displaced by an amount $\xi = -a\rho_1/2n_0$, where $\rho_1 = N_1 m(e/m)^2$, and is thus proportional to the density of the electrons of the N_1 group, which is assumed proportional to the ordinary density of the gas. Hence the above conclusions. Applying the theory to the inverse Zeeman-effect, it is shown that it accounts for a symmetrical Zeeman triplet in the ordinary way, but shifted in the manner of the single line and by an equal amount. Extending the theory to the case of two "bound" electrons, it appears that the single line is separated by the magnetic field into two lines at equal distances from the position $\xi = -a\rho_1/4n_0$, but of unequal intensities. One of these lines would be invisible in a weak field, but in a strong magnetic field the two lines would have equal intensities. The separation produced by the field is superposed on an initial distance $(a\rho_1/2n_0)$ apart of the two lines, which is the same as the pressure shift of the single line, so that those lines showing a good pressure shift will also show a good separation under the action of a magnetic field. Similar results are obtained for emission lines and for the direct Zeeman-effect, and comparison is made as regards numerical results with the observations of Natanson, Humphreys, and Haschek and Mache. Fair agreement is obtained. A. W.

1840. *Fluorescence of Vapours of Alkaline Metals.* **L. Dunoyer.** (Le Radium, 9. pp. 177–186, May, 1912.)—The first half of the paper contains a summary and discussion of previous work on the fluorescence of sodium vapour, particularly that of R. W. Wood. The second part describes the author's own experiments [see also Abstract No. 1683 (1911)]. The tube containing the fluorescent vapour was about 8 or 10 cm. long and 35 mm. wide. It is blown out at one end into a bulb of slightly larger diam., which is connected to the pump and to the tube containing the sodium by means of two fine tubes with capillary portions. The other end of the original tube is then closed and also blown out into bulb form. The experiments show that, under excitation by white light, pure sodium heated to between 250 and 400° gives by fluorescence or resonance the D radiation exclusively. The green channelled fluorescent spectrum is only seen when the Na-vapour is adulterated with gases given out by the metal. It seems necessary to infer that the atoms or molecules of these gases associate themselves with the atoms of Na in emitting electromagnetic energy, unless the improbable assumption be made that these foreign atoms on freeing themselves from the Na are in a peculiar state in which they are capable of independently becoming fluorescent and emitting the channelled spectrum. That the nature of the association is extremely unstable under the conditions of the experiments, is shown by the facility with which a slight diminution of pressure in the freed gases, the temperature remaining constant, weakens the green fluorescence to the profit of the yellow, and also by a certain peculiarity in the process of discolouration of the glass. The compounds Na_2H and NaH tend to dissociation above 300°, so that if the green fluorescence were due to them one would expect it to become fainter as the temperature increases, which however is not the case. Provisionally the author conceives the vibrators giving rise to the channelled spectrum to be complex systems formed of an atom (or molecule) of Na associated with smaller material elements, in a fugitive or shifting combination in perpetual course of formation and dissociation. These elements may be constituted of atoms of hydrogen, or by fractions of atoms (ions or electrons). The unstable doublets discovered by Righi and J. J. Thomson in canal rays are cited as affording an instance of similar complexes. There may be any number of supplementary elements associated with the Na atom; associations comprising 1, 2, 3, ... n supplementary elements may occur simultaneously in the vapour. This hypothesis would explain the series of lines equidistant in the scale of wave-lengths observed by Wood in the channelled region of the spectrum when the vapour is excited by a monochromatic source. Just as an organ-pipe, the length of which is increased in arithmetical progression, emits sounds of wave-lengths increasing in arithmetical progression, so one may imagine a system of resonators having one part analogous for all (the sodium atom) and 1, 2, 3, ... *n* supplementary elements, to be capable of entering into resonance and emitting wave-lengths in arithmetical progression. The lines wanting in the series would correspond to molecular associations which were non-existent, or were not represented, owing to great instability. It is possible that the nature of the exciting light itself may have influence on these fugitive associations by affecting their number relative to the number of free remaining sodium atoms. This would explain why slight variations in the intensity of certain rays of the exciting white light may render predominant phenomena of resonance due to one or another system of resonators. A. E.

1841. *Fluorescence of Vapours of Alkaline Metals.* **L. Dunoyer.** (Le Radium, 9. pp. 209–218, June, 1912.)—The author has previously shown [see preceding Abstract] that the fluorescence excited in an atmosphere of pure Na-vapour by a beam of white light is orange-yellow, and not green as stated earlier by Wiedemann and Schmidt. In the present paper the polarisation of the light emitted by the vapours of Na, K, and Rb, rendered fluorescent by white light, is dealt with. Most of the results of the work described have already been given [Abstract No 1683 (1911) and preceding Abstract], but the present paper gives much more detail. With regard to the variation of the polarisation with the orientation of the plane of polarisation of the exciting light, it is found that the values of the polarisation corresponding to two definite orientations of the incident electric vibration have a constant ratio to one another, which is independent of the temperature. In the light emitted laterally by the fluorescence, the excess of the energy of the electric field perpendicular to the plane of observation over that of the electric field parallel to this plane is found to be proportional to the component along the normal to the plane of the exciting electric field. Further work on the variation of the polarisation with density of vapour, the temperature remaining constant, and on the variation with temperature, the density of the vapour being constant, will be given later. [See also Abstract No. 1427 (1908) and next Abstract.] A. W.

1842. *Fluorescence and Absorption of Vapour of Rubidium, and of Mixtures of Rubidium and Caesium.* **L. Dunoyer.** (Le Radium, 9. pp. 218–223, June, 1912.)—Describes in detail the results of a spectroscopic examination of the above. It is shown how the fluorescence spectrum (for which wave-lengths of the bands are given) of Rb varies as the temperature rises. In the investigation of the absorption of the Rb and Cs mixture it was found that at 310–320° C. there appeared very faintly in the orange region a fine line of wave-length 625 $\mu\mu$, and a faint band in the green reaching from 563 $\mu\mu$ to about 559 $\mu\mu$. Both these increase considerably in intensity as the temperature rises. This effect does not seem to have been noticed by Bevan in his research on the absorption of Cs-vapour emitted by a mixture of Na, K or Li and CsCl. With Na-vapour it was found [see Abstract No. 1840 (1912)] that the fluorescent beam produced by the light emanating from the positive crater of a carbon arc is green, while the light from the negative carbon excites an orange fluorescence. In the Rb and Cs mixture a similar effect was noticed. At a temperature of about 250° C., when the fluorescence of Rb is red and has not reached the orange colour, which is obtained at higher temperatures, with the carbons of the arc close together, the red fluorescence is obtained. But when the carbons are separated the beam produced by the positive crater remains red, while that produced by the negative carbon is orange. This effect is discussed. A. W.

1843. *Spectroscopic Investigations of the Phosphorescence and Excitement-distribution of some Alkaline Earth Phosphores.* **A. Bachem.** (Ann. d. Physik, 38. 4. pp. 697–720, July 12, 1912.)—The author has repeated, and in the main confirmed, experiments performed by Lenard and Klatt [see Abstract No. 726 (1905)], who applied the term excitement-distribution (Erregungsverteilung) to the relation between the wave-length of the exciting light and the intensity of the excited phosphorescent light. The substances examined were prepared from the directions of Lenard and Platt, and are brilliantly phosphorescent; their abbreviated designations are: CaBiNa, SrBiNa, SrZnF, BaBiK, BaCuLi. The results are given in great detail. Lenard and Klatt found the excited energy distribution to be independent of the temperature, but the author finds that the temperature exercises a slight influence in shifting the maximum towards the longer wave-lengths, without however affecting the intensity. In certain of the phosphores, which strongly absorb violet light, it is found that the max. excitement has slightly greater wave-length than the max. absorption, and the minimum excitement slightly less than the minimum absorption. Any shift of excitement maxima of phosphores depending upon the various earths and metals entering into their composition is very slight for the shorter wave-lengths, and fairly marked for the longer. In two extreme instances a slight divergence from Stokes' law is found. The bands of exciting and excited light overlap, and since light from any portion of the exciting band excites the whole region of the phosphorescing band, the law, which states that the wave-length of the excited light is greater than the wave-length of the exciting light, does not here hold good. The case would be met by a slight alteration of wording, making Stokes' law read "the maximum of excited light has greater wave-length than the maximum of exciting light." A. E.

1844. *Ionisation Curve for α-Rays from Polonium in Mercury Vapour.* **T. S. Taylor.** (Phil. Mag. 24. pp. 296–301, Aug., 1912.)—The experiments described are in continuation of the author's work on the Bragg ionisation curves in various gases. [Abstract 889 (1911).] Since the vapour pressure of Hg-vapour is low at ordinary temperatures, it was necessary to design and use an apparatus adapted to temperatures as high as 350° C. The apparatus used was similar in principle to that ordinarily employed, and consisted of a shallow ionisation chamber of gauze and a polonium source which could be moved at right angles to the chamber in such a way that the ionisation current measured represented the number of ions produced at different parts of the range. The actual temperature used was 330° C., the vapour pressure at this temperature being 471 mm. and the range about 7·1 cm. The ionisation curve was compared with that obtained by using air at the same temperature and with the range adjusted by pressure to be the same as that in the Hg-vapour. The curve obtained for Hg was found to be approximately of the usual shape $I = C/(R - x)^{\frac{1}{3}}$, where I is the ionisation at distance x from the source, R the range of the α-particles, and C is a constant. The agreement, however, was not quite so close as with other gases previously examined. By measuring the areas of the ionisation curves for Hg-vapour and air a relative measure of the number of ions produced in the two gases was obtained. The reciprocal of this ratio was found to be 0·72, which therefore represents the relative amount of energy required to produce an ion in Hg-vapour. E. M.

1845. *Secondary Rays excited by α-Rays of Polonium.* II. **V. E. Pound.** (Phil. Mag. 24. pp. 401–414, Sept., 1912. Paper read before the Canadian

Inst., Toronto, Jan. 18, 1912.)—In a previous paper the author suggested that when α-rays from polonium strike a carbon or brass plate the secondary, or δ, radiation is due to the presence of gas occluded at or deposited on the surface of the plate [Abstract No. 1206 (1912)]. The present experiments show that in the case of carbon, the secondary radiation increases in intensity as the temperature of the carbon is lowered from room temperature to the temperature of liquid air, and this is shown to be due to an increase in the amount of gas occluded in the surface of the carbon. The measurements were carried out at very low pressure in air, hydrogen, and oxygen, the usual charging-up method being adopted. The author suggests that the procedure constitutes a new method of studying the phenomena of occlusion. The results of the experiments also go to show that with a metal like brass, the amount of a gas retained in its surface when it is placed in vacuum is less at the temperature of liquid air than at ordinary room temperature. E. M.

1846. *δ-Rays.* **R. D. Kleeman.** (Phil. Mag. 24. pp. 198–201, July, 1912.)—Experiments by Campbell [Abstract No. 1035 (1912)] indicate that there is no difference in the numbers of emergent and incident δ-rays emitted by a metal-foil under the influence of α-rays. This result is in some respects antagonistic to a former result of the author that in ionisation the electron has a component of motion in the direction of the α-particle producing the ionisation [Abstract No. 561 (1910)]. In the present paper the previous experiments are discussed more fully, and more especially from the point of view of the author's theory of the nature of an ion cluster. The validity of the original conclusions is maintained, the author considering that more reliance can be placed on what happens in a gas between electrodes than what happens at their surfaces. E. M.

1847. *Diffusion of Actinium Emanation.* **J. C. McLennan.** (Phil. Mag. 24. pp. 370–379, Sept., 1912. Paper read before the Roy. Soc. of Canada, May 17, 1912.)—The paper gives a theoretical discussion of the results of some experiments by Kennedy [Abstract No. 2067 (1909)], who found that at low pressures a large amount of the active deposit from actinium emanation is collected at the anode, and not wholly at the kathode as is usual. The experiments are discussed mainly from the point of view as to whether or not the active-deposit particles are uncharged at the moment of their formation and subsequently acquire their charge from the gaseous ions. Experiments are in progress. E. M.

1848. *Radio-active Recoil from Polonium.* **B. Bianu** and **L. Wertenstein.** (Comptes Rendus, 155. pp. 475–477, Aug. 26, 1912.)—Polonium was deposited on a plate of silver 6 cm. in diam., which was then placed as the lower of two parallel electrodes about 6 mm. apart. The ionisation current between the electrodes was measured for different pressures from 1 to 40 mm. Hg with a transverse field of about 1100 gauss to eliminate the effect of the δ-rays. From the curve obtained the existence of a recoil ionising radiation was deduced. The recoil atoms were found to be completely absorbed in a distance d mm. in air when $pd = 70$, where p is the pressure in mm. of Hg. Previous experiments have shown that for the recoil radiation from RaC the corresponding value of pd is 120, and these numbers are approximately in the ratio of the ranges of the α-particles producing the recoil. It was found that to show the effect it is necessary that the thickness of the polonium coating on the silver should be of the order 10 μμ. [See Abstracts Nos. 691, 1586 (1912).] E. M.

HEAT.

1849. *Summary of the Specific Heats of Gases.* **G. N. Lewis** and **M. Randall.** (Amer. Chem. Soc., Journ. 34. pp. 1128–1134, Sept., 1912.)—A summary is given of the observations that have been made on the specific heats of gases by direct methods, by adiabatic methods, in which the ratio of the specific heats is determined, and finally by explosion methods. From these observations the authors have calculated formulæ in which the figures given by different observers are averaged. These are as follows (T = abs. temp., C_p = mol. heat, at const. pressure) :—

Monatomic gases.................. $C_p = 5·0$
N_2, O_2, CO, NO, HCl, HBr, HI $C_p = 6·50 + 0·0010T$
H_2 .... $C_p = 6·50 + 0·0009T$
Cl_2, Br_2, I_2 .... $C_p = 6·5 + 0·004T$
H_2O, H_2S ...$C_p = 8·81 + 0·0019T + 0·00000222T^2$
CO_2, SO_2......$C_p = 7·0 + 0·0071T - 0·00000186T^2$
NH_3............$C_p = 7·5 + 0·0042T$

T. M. L.

1850. *Thermodynamic Properties of Liquid Water to 80° C. and 12,000 kg./cm.² Pressure.* **P. W. Bridgman.** (Amer. Acad., Proc. 48. No. 9. pp. 309–362, Aug., 1912.)—This is a continuation of the author's previous work [see Abstract No. 257 (1912)] which has for ultimate object the accumulation of enough experimental data to form a theory of liquids. An unexpected fact disclosed is that the variation of dilatation does not become vanishingly small at high pressures, but reverses in sign, *i.e.* while at low pressure the volume increases more and more rapidly with rising temperature, at high pressures the expansion becomes more slow at high temperatures. Other abnormalities present themselves to such a degree that water may scarcely be regarded as a normal liquid except at higher pressures and temperatures, and thus the results here are not of material help in forming a theory of liquids. The method of measuring the volume-changes consists simply of a moving piston which is displaced by the expanding fluid. Previous workers had great difficulty with this method because of the leakage. Tammann, to prevent leak, used castor oil, which, however, freezes at high pressures. Other workers used special packings of leather; but these disintegrate at 4000 kg./cm.². The author uses a packing of mild steel which works admirably at all pressures. The pressure is measured by a manganin coil which is previously calibrated against an absolute gauge; this is better than using the Bourdon type of gauge, which has serious hysteresis errors. The cylinder used is of chrome-vanadium steel with a tensile strength of 300,000 lbs. per sq. in. and an elastic limit of about 250,000 lbs. per sq. in. It is made in the electric furnace and therefore remarkably homogeneous. The corrections for distortion of the cylinder are troublesome at higher pressures because of hysteresis; auxiliary experiments are made to determine this. The insulation of the coil and its calibration are discussed at length, and the probable errors and necessary corrections indicated. The compressibility and dilatation of water are determined [the change of volume at 40° seems slightly lower than that found by Amagat] and a $pv\theta$ table is given. From this table the author deduces several points of thermodynamic interest and importance. In these experiments kerosene is employed as an auxiliary liquid in which the manganin coil is placed and the pressure produced; the $pv\theta$ table for kerosene is also given. Abnormalities occur in kerosene because of the various components with different melting-points. The separation of the components lessens the sharpness of the transitions. The author's apparatus is suitable for measuring the compressibility and dilatation of ice, and he includes a short discussion of the values obtained from 0° to 20° and from 6360 to 10,000 kg./cm.^{2}. H. S. R.

1851. *Isotherms of Monatomic Substances and of their Binary Mixtures. XIII. Empirical Reduced Equation of State for Argon.* **H. Kamerlingh Onnes** and **C. A. Crommelin.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 273–280, Sept. 8, 1912. Communication No. 128 from the Phys. Lab., Leiden.)—The authors communicate a special reduced empirical equation of state for argon, which embraces data obtained from observations made in both the vapour and the gaseous states. The equation is written in the form $pv_A = A_A + B_A/v_A + C_A/v_A^2 + D_A/v_A^4 + E_A/v_A^6 + F_A/v_A^8$, and the authors have evaluated the constants for temperatures from −149·60° to +20·39°. They also add a table showing the agreement between this equation and observation. [See Abstracts Nos. 1521, 1523 (1911).] A. F.

1852. *Radiation Laws for Metals.* **E. P. Hyde.** (Astrophys. Journ. 36. pp. 89–132, Sept., 1912.)—The principal purpose of the present investigation has been to construct synthetically, as far as possible, the laws governing the radiation from untreated carbon, flashed carbon, tantalum, and tungsten, starting from certain simple photometric and electrical measurements. Two criteria are established which conduce to certain more or less definite conclusions regarding the laws of radiation of glowing solids, and these criteria are applied to the filaments mentioned above. Criterion I, if fulfilled, points strongly to the constancy of the emissivity of a substance with change of temperature for the region of the spectrum in which it is tested. If not fulfilled it indicates definitely a change of emissivity with temperature. As applied to the various filament materials it leads to the conclusion that the emissivities in the visible spectrum of untreated carbon, flashed carbon, and tantalum are probably constant within the limits of attainable accuracy over the range of temperature employed, but that the emissivity of tungsten in the visible spectrum probably undergoes change with a change in temperature. The criterion conduces definitely to the following equation representing the distribution of energy in the spectral region in which it is fulfilled: $J = C_1 f(\lambda)/e^{c_2/\lambda\theta(T)}$. If the criterion is taken to indicate constancy of emissivity, the equation becomes $J = C_1 F(\lambda)/(\lambda^5 e^{c_2/\lambda T})$, which is the Wien equation for a black body, multiplied by the function $F(\lambda)$. Criterion II, taken in conjunction with Criterion I, leads to the following relation between the total emission and the temperature: $E = S'[\theta(T)]^\beta$. If Criterion I is taken to indicate constancy of emissivity, the above equation becomes $E = ST^\beta$, the generalised form of the Stefan-Boltzmann law for a black body. All four of the filament materials investigated conform to the requirements of Criterion II, and hence for all, except tungsten, the latter equation for total emission probably holds within the limits of temperature employed. On this assumption the following values of β have been computed: 4·0 for untreated carbon; 4·1 for flashed carbon; and 4·7 for tantalum. A similar computation for tungsten, neglecting the indicated lack of constancy of its emissivity, gives 6·0. In addition to these results, the paper contains a general discussion of the radiating properties of metals. A. W.

1853. *Radiation Constant.* **L. Puccianti.** (N. Cimento, 4. Ser. 6. pp. 31–48, July, 1912.)—The author has determined the value of σ, measuring, by means of a specially devised bolometer, the amount of heat required to maintain one black body (which is of manganese and forms part of the bolometer) at atmospheric temperature, when exposed to the radiation from another black body kept at a temperature of liquid air or carbonic acid snow, and making use of Lambert's law that the exchange of heat between two black bodies at temperatures Θ and ϑ is given by $\phi = \mathrm{K}\sigma(\Theta^4 - \vartheta^4)$, where K is a geometrical coefficient depending on the areas. The mean value obtained for σ is 5·96, which is considered to have a limit of error of 3 per cent. [See also Abstracts Nos. 1229, 1230, 1231 (1912).] W. H. Sı.

1854. *Heat of Transformation and Reversible Work.* **E. Kohl.** (Monatsh. f. Mathematik u. Physik, 23. pp. 81–91, 1912.)—Discusses Nernst's theorem connecting the heat of transformation in a condensed system with the maximum efficiency, and Sackur's specification of an ideal solid satisfying that theorem [Abstract No. 906 (1911)]. Shows that the thermodynamic equations lead to the addition of a very small term, whose form gives a criterion for determining whether Nernst's theorem is valid for any given system, and how great are the discrepancies in other systems. This is done by means of a system of formulæ previously devised by the author [see Abstract No. 1219 (1908)], and amplified for the present purpose. E. E. F.

1855. *Canonical Equations for Solids on the Quantum Theory.* **K. Eisenmann.** (Deutsch. Phys. Gesell., Verh. 14. 15. pp. 769–774, Aug. 15, 1912.)—Recently various physicists have endeavoured to derive an equation of state for solid bodies, prominent among these being the theories of G. Mie, of Grüneisen, and of Einstein [see Abstracts Nos. 1450 (1904); 439 (1907); 942 (1912)]. The present author proceeds by calculating the entropy and energy, and then derives the equation of state, which, for a spherical atom, has the form—

$$p + \frac{a}{v^2} = \frac{k\mathrm{T}}{v - v_0} + \frac{1}{v} \cdot \frac{h\nu}{e^{h\nu/k\mathrm{T}} - 1}$$

E. H. B.

1856. *Entropy and the Equation of State.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 240–256, Sept. 3, 1912. Supplement No. 24*a* to the Communications from the Phys. Lab., Leiden.)—Gives a method of obtaining the equation of state of a single-component substance from Boltzmann's entropy principle. The momentary state (Planck's "micro-state") is determined in the case of a system whose motions, under the influence of their mutual forces, can be regarded as determined by Hamilton's equations in terms of a finite number of generalised co-ordinates and the corresponding momenta for each molecule. It is assumed that all micro-complexions represent cases of equal probability. Then the probability of the occurrence of any group macro-complexion is proportional to the number of micro-complexions contained in it. Boltzmann's entropy principle can then be formulated in such a way that the entropies of different macroscopically determined states are proportional to the logarithms of the probabilities of the different group macro-complexions corresponding to those macro-states. E. E. F.

1857. *Internal Energies of a Substance.* **R. D. Kleeman.** (Cambridge Phil. Soc., Proc. 16. pp. 584–599, July 24, 1912.)—Endeavours to separate the effects due to the energy necessary per molecule to separate the molecules of a mass of substance by an infinite distance from one another and the internal energy of a molecule. This is only possible to a certain extent. The law of attraction between two molecules should depend somewhat on the vicinity of other molecules, and also on the temperature, especially if the molecules are complex. A change in the internal energy of a molecule is associated with a change in the configuration of the atoms, which are probably not concentrated at a point, and this change must be attended by a change in the law of molecular attraction. The law of attraction deduced from the surface tension and the internal heat of evaporation of liquids is a mean law depending on the configuration of the atoms in the molecules as well as on their number and nature, and therefore differs considerably from that expressing the attraction between two atoms. Thus it is conceivable that the law of molecular attraction may involve the critical constants, and contain the temperature as one of the variables. [See also Abstract No. 757 (1912).] E. E. F.

1858. *New Hypothesis with respect to the different States of Aggregation and the different Modifications of a Substance.* **L. Schames.** (Ann. d. Physik, 38. 4. pp. 830–848, July 12, 1912.)—The energy-content (E) of a body is defined by the equation—

$$E/T = \left\{ \int_0^T C dT + L \right\} \Big/ T,$$

where L is the latent heat, and C is the specific heat, as defined by the expression $dE/dT = C$. The relation between the specific heat and the temperature being known down to the absolute zero [Abstract No. 1702 (1911)], the energy-content of a body can be calculated before and after fusion, and the author shows that there is a simple relation between the energy-content before and after the change of state. This relation is $r/T =$ const., where r is the atomic (or molecular) heat of the body, and T is the melting-point; the constant, which the author states to be approximately a whole number, although the figures given do not warrant this, holds only when elements in the same group of the periodic system or when similar compounds are compared. The relation is thus similar to Trouton's rule for the latent heat of vaporisation. In order to account for the above constant and Trouton's rule, the author puts forward the hypothesis that every alteration of the state of aggregation is accompanied by a change in molecular constitution, the number of atoms to the molecule being the greatest in the solid state and least in the vapour state. For example, mercury vapour is monatomic, whilst the liquid is tetratomic; benzene vapour has the formula C_6H_6, whereas the liquid is $(C_6H_6)_3$ and the solid $(C_6H_6)_4$; water-vapour is H_2O, whilst water is $(H_2O)_3 - (H_2O)_6$, and ice is $(H_2O)_{12}$. The objections which may be raised to this hypothesis are fully discussed by the author and shown to be untenable; they consist of difficulties in connection with the following: (1) continuous transition from the gaseous to the liquid condition; (2) dependence of the heat of vaporisation on the pressure; (3) determination of molecular weight by surface-tension methods; (4) difference between the so-called associated and non-associated liquids. The case of sulphur is also considered, and it is shown that the allotropic forms of various elements depend on changes in the molecular structure. Similar structural changes will account for the appearance of ferromagnetic properties. T. S. P.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1859. *Unipolar Induction.* **E. H. Kennard.** (Phil. Mag. 23. pp. 937–941, June, 1912.)—In Faraday's classical experiment on unipolar induction, a bar magnet is rotated about its magnetic axis while a wire leading to a galvanometer makes sliding contact at one end and in the middle. The resulting current may be produced in the wire by the lines of force rotating with the magnet, or in the magnet rotating in its own field. It is impossible to decide which of these is the correct alternative so long as closed circuits are employed. The author therefore substitutes an electrometer for the galvanometer. The magnet is a steel cylinder enclosed in a coil by which it is magnetised. The bar and coil are enclosed in a continuous metallic case to avoid electrostatic influences outside, such as might be expected on the second view. This case, and an outer cylinder, connect through the electrometer. On the first view the theoretical deflection was 26 to 37 divisions on an electrometer giving 850 divisions per volt. The observed deflection was 11 divisions maximum, the average being 4 divisions. It is concluded that the magnet does not carry its lines of force round with it. E. E. F.

1860. *Arrangement to find e/m.* **H. Greinacher.** (Deutsch. Phys. Gesell., Verh. 14. 18. pp. 856–864, Sept. 30, 1912.)—Describes with a detailed diagram a suggested experimental arrangement for the determination of e/m by the slow electron rays from incandescent oxides. The actual experiment on this plan has not yet been carried out. E. H. B.

1861. *Mass of the Electron.* **W. Schottky.** (Phys. Zeitschr. 13. pp. 421–425, May 15, 1912.)—Discusses the question whether any system or particle can be regarded as possessing a constant mass, in view of attempts by Lorentz and others to reduce relativity dynamics to constant masses of subatomic magnitude. Concludes against the possibility of any constant mass, in view of the failure of the electron itself in that respect. E. E. F.

DISCHARGE AND OSCILLATIONS.

1862. *Emission of Electrons by Metals under the Influence of α-Rays.* **H. A. Bumstead** and **A. G. McGougan.** (Amer. Journ. Sci. 34. pp. 309–328, Oct., 1912. Phil. Mag. 24. pp. 462–483, Oct., 1912.)—The experiments are in continuation of those by Bumstead described in Abstract No. 198 (1912) which indicated that the curves connecting the emission of δ-rays from a plate with the range of the α-particles falling on the plate are similar in general characteristics to Bragg ionisation curves. The authors have determined such curves for Al, Cu, Au, Pb, and Pt, the ranges of the α-particles falling on thick plates of the metals being varied by placing foils of Al over the polonium source used. The curves were found to have the same form for all the above metals, this agreement being in contrast with the fact that ionisation curves for different gases show marked differences in form. The magnitude of the δ-ray effect and the field necessary to cause saturation were found to decrease progressively for some time after the metals were first enclosed in vacuum, although the form of the curve referred to above did not change. These results suggest that the whole effect may be due to a layer of absorbed gas which is gradually removed in vacuum. However, an experiment in which a strip of Pt was heated to red heat in a high vacuum failed to give evidence of the removal of this supposed film. As described in Abstract No. 1208 (1912) the authors have also obtained evidence of a radiation emitted from polonium, more penetrating than ordinary δ-rays. Part of this is now ascribed to recoil atoms, the other part is secondary and consists of electrons whose velocities range from less than $3{\cdot}8 \times 10^8$ to more than $24{\cdot}4 \times 10^8$ cm./sec. The secondary radiation is emitted not only by the source but by any object on which the α-rays are incident. A part, at least, of the ordinary δ-radiation is due, not to the direct action of the α-rays, but to these secondary rays; indeed it is quite possible that the whole of the δ-ray effect may be thus produced. E. M.

1863. *Mass and Mobility of Positive Flame Ion.* **G. Moreau.** (Le Radium, 9. pp. 273–276, Aug., 1912.)—The method employed consists in the use of two neighbouring Bunsen flames with a gauze separating them. The positive ions formed in one flame, when a Pt wire dipped in a salt is placed in it, are driven by a small electric field through the gauze and eventually arrive on a Pt kathode coated with lime in the other Bunsen flame. The distribution of the field was examined by Pt wires connected to an electrometer, and it was found that the lime decreased the kathode-fall of potential, making the field much more uniform. Relations were obtained between the mobility, the current, etc. The mean value for the mobility at 1400° abs. was deduced to be 12 for salts of Rb, Na, Li, Ca, Si, and Ba, and was, within the limits of experimental error, independent of the nature and concentration of the salt employed. This is not in agreement with the results of Lusby [Abstract No. 367 (1912)], who found differences in the mobility of monovalent and divalent metals. The author deduces that the positive ion at 1400° consists of from 3 to 10 molecules, while at 1900° it consists of a single molecule of the metal of the salt. E. M.

1864. *Ionisation by Collision in Gases and Vapours.* **W. R. Barss.** (Amer. Journ. Sci. 34. pp. 229–241, Sept., 1912.)—Alpha radiation is employed as the ionising agent. The object is to determine the collision constants corresponding to α-rays, and to ascertain whether these constants are dependent on the nature of the ionising source. Some vapours, *e.g.* sulphur dioxide, ethyl alcohol, ether, methyl iodide, and ethyl chloride, are also used in the experiments. The collision constants are shown to be independent of the nature of the ionising agent; therefore the negative ions generated in a gas by collisions with the α-particles, are identical with those generated by Röntgen rays and ultra-violet light. The theory of ionisation by collision as developed for gases holds for vapours ionised by α-particles provided the pressure is not too high. As the pressure is increased, evidence of irregularity is obtained which seems to point to some instability in the molecular structure of vapours, either due to the formation of aggregate molecules or to some chemical change. In vapours, as in gases, the negative ion alone is effective in producing new ions by collisions with neutral molecules, until the sparking potential is approached. A. E. G.

1865. *Ionisation Power of Negative Ions by Collisions at High Pressures.* **E. W. B. Gill.** (Phil. Mag. 24. pp. 293–296, Aug., 1912.)—The paper deals mainly with a criticism of some experiments by Bishop on ionisation by collision [Abstract No. 865 (1912)] in which results were obtained which differed somewhat from those of Townsend. Both the experimenters start with the fundamental equation $n = n_0 e^{\alpha d}$, where n_0 is the number of ions starting from a negatively charged plate (excited by ultra-violet light) and n is the number reaching a parallel plate at distance d. The difficulty of obtaining n_0 was evaded by Townsend by using two distances d_1 and d_2 with corresponding values n_1 and n_2. Thus the constant α was obtained from the equation $n_1/n_2 = e^{\alpha(d_1 - d_2)}$. Bishop, on the other hand, obtained experimentally a complete current-e.m.f. curve keeping d constant, and estimated n_0 from the saturation portion of the curve. The present author objects to this latter method, pointing out that in no case is the saturation curve parallel to the axis of x. The author has also made experiments and redetermined some of the values of α for air at the pressures investigated by Bishop, but using Townsend's method. The results indicate that the values of α deduced by Bishop are all far too low. E. M.

1866. *Secondary Kathode Rays in Gases, Generated by very great Primary Velocity.* **S. Bloch.** (Ann. d. Physik, 38. 3. pp. 559–587, June 18, 1912.)—A method is described for calculating the conductivity generated by the primary rays in a gas when the total conductivity is known: the method depends upon the secondary radiation produced in the gas. Part of the reflected and secondary radiation are not produced directly by the primary rays but are due to the influence of the walls of the vessel. The amount of this indirect radiation depends upon the size of the vessel, *e.g.* in a cylinder of zinc-foil 18 cm. high and 5·4 cm. diam. it accounts for 46 per cent. of the total conductivity. The conductivity for different-sized vessels can be calculated from a given formula. Absolute measurements which are carried out by means of a vacuum—and also with a paraffin condenser, give the result that a primary quantum of $2{\cdot}76 \times 10^{10}$ cm./sec. velocity generates in its path through 1 cm. of air at 760 mm. pressure 54 secondary quanta. It is thus incidentally proved that the paraffin condenser is suitable for this kind of quantitative measurements. By conductivity determinations in other gases it is found that an electron of the above-given velocity can generate in 1 cm. of its path 86 secondary quanta in CO_2, 84 in coal gas, and 7 in hydrogen. In CO_2 the secondary radiation produced is what might be expected from the mass; on the other hand, hydrogen shows a deviation in this respect which diminishes with increasing velocity as can be seen by comparison of the earlier results obtained by Kossel and Strutt. With the help of a "normal" vessel which is described, it is possible from the measurement of the conductivity to arrive at a conclusion as to the quantity of UrX present. It is claimed that from these results it is possible to show the total dependence of secondary radiation in gases on the primary velocity within limits 0 to 3×10^{10} cm./sec. A. E. G.

1867. *Kathode Rays.* **A. Wehnelt.** (Deutsch. Phys. Gesell., Verh. 14. No. 18. pp. 832–836, Sept. 30, 1912.)—In discharge tubes of suitable form there occur at low pressures, in addition to the visible slightly divergent bundle of rays, other rays proceeding from the entire kathode which cause the glass walls quite up to the electrode to fluoresce. A special tube for the study of these is described; the gas employed is hydrogen. It is shown that rays proceed from the kathode even up to its edge, and that these rays diverge in all directions. The potential calculated from the magnetic deflection is found to be in satisfactory accord with that measured by means of an electrometer, and from the results so obtained it is concluded that these rays always proceed from the kathode, with a velocity which is smaller, the nearer the point of emission lies to the edge of the kathode. A. E. G.

1868. *Penetration of Canal Rays into Solids.* **J. Stark** and **G. Wendt.** (Ann. d. Physik, 38. 5. pp. 921–940, Aug. 13, 1912.)—The stating of the problem and its theoretical consideration occupies several pages at the beginning of the paper. Sketches of the apparatus employed are given. Hydrogen canal rays of kathode-fall up to 5000 volts scatter the *smooth* surfaces of calcspar, fluorspar, glass, and quartz; they, however, do not destroy the polish. Plates of rock-salt, sylvine, and mica are perceptibly roughened by the impact of slow canal rays. Canal rays of kathode-fall greater than 10,000 volts roughen the surface of glass, fluorspar, calcspar, mica, sylvine, rock-salt in increasing degrees in the order given. The surface of quartz is not roughened in spite of considerable scattering. Mercury canal rays in the case of calcspar produce a chemical change in the surface on account of the heating which takes place; they also produce a scattering effect in all the substances tried without causing a roughening of the surface at the point of impact. The mechanical deep action of the hydrogen canal rays cannot be explained by the penetration of the rays through the intermolecular valency fields under the surface layer. Solid metals are made dull through scattering by means of slow hydrogen canal rays. The surface of the base of a bismuth crystal is not noticeably roughened by slow canal rays and only very slightly by rapid rays; the rays have a much greater scattering effect upon a surface the plane of which is approximately perpendicular to this direction. A. E. G.

1869. *Transmission in a Solid of the Shock due to Canal Rays.* **J. Stark** and **G. Wendt.** (Ann. d. Physik, 38. 5. pp. 941–957, Aug. 13, 1912.)—The theoretical aspect of the problem is considered at some length. An experimental solution is sought by exposing for some time one surface of a plate with parallel plane faces to the action of very rapid canal rays, and noting whether any slight elevation occurs on the other surface immediately over the point of impact of the rays. The apparatus is sketched in another paper [see preceding Abstract]. Plates of rock-salt cut parallel to one of the cubic faces and 0·8–1 mm. in thickness shows such an elevation after 30 minutes' exposure to hydrogen rays when the kathode-fall is greater than 5000 volts. Fluorspar plates 0·8–1 mm. in thickness, cut at right angles to the principal cleavage plane, exhibit no elevation on the reverse side when exposed to slow hydrogen rays, but may do so with kathode-fall greater than 10,000 volts after an exposure of more than 2 hours. A calcspar plate 0·8 mm. thick, cut at right angles to the principal cleavage plane, shows no elevation on the reverse side after 2 hours' exposure to very rapid hydrogen rays. On the other hand, a plate 1 mm. thick, cut at right angles to the optical axis, gives a clear indication to the action taking place over the point of impact of very rapid rays after an exposure of 3 hours. An explanation of this phenomenon is developed on the assumption that the point of impact becomes charged up electrically and forms a repelling force between that point and subsequent canal rays. A. E. G.

1870. *Further Experiments on Positive Rays.* **J. J. Thomson.** (Phil. Mag. 24. pp. 209–253, Aug., 1912.)—Experience gained during the investigation of these rays has led to modifications in the apparatus which increase the brightness of the positive rays. The shape of the kathode and its position in the tube are important: an illustration of the section of the kathode giving best results is given. The tubes used for the discharge are spherical flasks about 80 cm. in diam., the kathode being in the neck of the flask. The brightness of the rays is very much affected by the extent to which the kathode projects into the flask; the best position is when the front of the kathode comes nearly flush with the opening into the flask. The space between the sides of the kathode and the neck of the flask must be small, otherwise when monatomic gases such as helium or argon are used there is a considerable deposition of metal on the neck of the flask; the discharge then tends to start from this deposit instead of from the kathode, and very few positive rays pass down through the hole in the kathode. For the channel through the kathode fine copper tubes are drawn out until the opening is sufficiently reduced. When smaller tubes are required, use is made of two flat pieces of steel made as accurately plane as possible. A shallow fine scratch is ruled on one of the plates, and the two plates are then bolted together. The following are some of the more important results obtained:— Photographs of positive rays show lines of two types: one type consists of a series of arcs of parabolas which, when the deflection due to the electrostatic field is horizontal, start in most cases from points lying on a straight vertical line. Since the horizontal electrostatic deflection is inversely proportional to the kinetic energy of the charged particles, this shows that the max. kinetic energy possessed by the particles producing these lines is the same for each kind of particle. These parabolic arcs are often of considerable length, indicating that there is a wide range of velocities among the particles of the same kind. The ratios of the *latera recta* of the different parabolas are equal to the ratios of the values of e/m for the particles producing the parabolas, and are independent of the strength and distribution of the electric or magnetic fields. The formation of these parabolic arcs which are termed primary lines, is attributed to particles which were charged before they entered the electric and magnetic field, and which have retained their charges unaltered during their passage from one end of the field to the other. When, however, the pressure of the gas traversed by the rays after passing through the kathode is not too low, there are other lines to be seen on the plate which have quite different properties from the primary lines. They form curves of fairly uniform intensity which do not stop short at a finite distance from the vertical axis but are continued until they meet this axis; in some cases they pass through the origin itself, in others they start from points vertically above or below it. They are found on the side of the plate corresponding to negative charges as well as on that corresponding to positive. Their shape and also their position with respect to the primary lines depends upon the disposition as well as on the intensity of the electric and magnetic fields. When the electric and magnetic fields are uniform and coterminous, these curves become straight lines passing either through the origin or very near to it. The straightness of these lines shows that the rays which produce any one line must be moving with nearly the same velocity, the fineness of the lines showing that the variations in the velocity must be exceedingly small. A secondary line may suffer considerable variation in position, and there is some danger, unless precautions are taken, that a secondary which has been displaced owing to some change in the distribution of the magnetic or electric fields might be regarded as a line due to a different kind of particle. When photographs of the positive rays are used to analyse the gases in the discharge tube, the lines due to the primary rays are the only ones that can be relied on. The tests for these primary lines are: (1) they must be parabolic, and (2) there should be a rapid increase in all these lines at places all situated on a vertical line. Arguments are given to account for the fact that although the primary line may be due to particles moving with a wide range of velocities, the particles in the secondary are all moving with the same velocity. The p.d. required to give the necessary velocity to the atom is shown to be so great as to account for the fact that secondary lines are only found with the lighter elements. The curves corresponding to negatively-charged particles may, like the positive ones, be divided into two types. Some of the negative lines corresponding to the secondaries among the positives come close up to the origin, while there are others which, like the primaries among the positives, are finite arcs of parabolas, terminating abruptly when they approach within a certain distance of the vertical axis. The theory which seems most in accordance with the observations, is that the negatively electrified particles are due to systems which are positively charged when they are in the discharge tube, then, after passing through the kathode, get neutralised by combining with a corpuscle, and when in the neutral condition have so strong an affinity for a negatively-charged corpuscle that, in spite of the high velocity with which they are moving past it, they are able to capture the corpuscle and thus become negatively electrified. This attraction for the negative corpuscle depends upon the chemical properties of the atom. One very remarkable feature of the photographs is the length of some of the arcs of the parabolas corresponding to the positive rays. Since the kinetic energy possessed by the particle is inversely proportional to its horizontal deflection, the kinetic energies of particles having the same value of e/m must vary within wide limits. Assuming that the kinetic energy of the particle is due to the action upon it when in the dark space of the electric field, this variation in kinetic energy can be accounted for, if the ionisation which produced the positive rays occurred not merely at the end of the dark space, but to some extent throughout the whole of this space. The relative number of the different kinds of particles present in the positive rays is a quantity of fundamental importance for the consideration of the chemical changes which go on in the gas in the discharge tube; this quantity is now measured by receiving the particles separately on a Faraday cylinder and measuring the charge received by the cylinder. The photographic difference between atomic and molecular lines suggests that the charged atoms and charged molecules are produced by different processes. Kathode particles produce a different kind of ionisation to that caused by positive rays. The fast positive rays, it is suggested, disintegrate into atoms any molecules against which they strike. On the other hand, a fast kathode particle is able to penetrate into the atom, and would collide rather with individual corpuscles than with the atom as a whole. In general the result of such a collision would be to detach a corpuscle from the molecule without necessarily splitting it up into atoms. The photographs show that atoms of nearly all the elements with the exception of hydrogen occur with two charges, though the number of these doubly-charged atoms is always small compared with those having a single charge. Arguments are given to show that in some of the collisions which produce the charged ions the conditions are such that the ions receive a double charge, *i.e.* the ionisation does not appear in two stages. The possibility of double-charged ions gives a beaded appearance to the atomic lines, the beads appearing nearer the vertical line than the main portion. The molecular lines show frequently another type in which the beads instead of being nearer the vertical axis than the head of the parabola, are further away from it. It is suggested that these are due to the impact of the kathode rays against the walls of the glass, giving rise to slow secondary rays of great ionising power. The study of the positive rays reveals the existence of some compounds which have not hitherto been detected by chemical methods, *e.g.* H_3 and N_3 or N_3H. The existence of the first substance is interesting from a chemical point of view, if hydrogen is regarded as always monovalent. Nitrogen exists in an exceptionally large number of modifications, but no line corresponding to nitrogen with a negative charge has been found. When the discharge is passed through mixtures of H and O, H_2O_3 and also H_4O appear to be formed. When passed through CS_2 a new compound, CS, occurs. It is quite possible for an element to be in the tube without producing its line on the photographic plate. The view of the forces between the atoms in the molecule of a gas which is most in accordance with the behaviour of the positive rays, is that these forces are due to the atoms behaving somewhat after the manner of electrical doublets. Photographs have now been obtained of the so-called retrograde rays. In addition to the kathode rays and positively-electrified retrograde rays it is shown that there are negatively-electrified atoms and molecules streaming from the kathode. The max. velocity of the negative atom is about the same as that of the corresponding positive one. [See also Abstract No. 658 (1911).] A. E. G.

1871. *Photoelectric Effect in Antimony-Cadmium Alloys.* **K. Herrmann.** (Deutsch. Phys. Gesell., Verh. 14. 11. pp. 573–575, June 15, 1912.)—By the method described in the preceding Abstract, pure surfaces of various Sb-Cd alloys were examined as regards photoelectric fatigue. Pure Cd and pure Sb showed normal fatigue, which in Sb, however, was very slight. The alloys, on the other hand, all showed an increase in the current during the first hour or so, followed by a gradual decrease. This behaviour was more marked in an alloy consisting of equal weights of Sb and Cd. [See Abstract No. 1410 (1912).] E. E. F.

1872. *Potential Effect on Resistance of Photo-sensitive Bodies.* **C. Ries.** (Ann. d. Physik, 38. 4. pp. 721–730, July 12, 1912.)—The author concludes from a study of various bodies whose resistance depends upon the illumination that in all cases the resistance also varies with the applied voltage, though this relation cannot be reversed with certainty. Among these substances are selenium, antimony sulphide, the earth alkali phosphores, and sulphur, shellac, anthracene, and paraffin [Abstract No. 192 (1912)]. The author himself observed a potential effect in silver sulphide, silver chloride, and tellurium, but not in a crystal of columbite, which is not photo-sensitive, nor in psilomelane. Bridges of silver chloride, prepared by spreading two coils of parallel silver wire with an ammoniacal solution of AgCl and evaporating, showed a considerable potential effect, accompanied by a lessened photo-effect under the higher potentials, and selenium behaved similarly. Bridges of small potential effect showed a smaller decrease of the photo-effect at high p.d.'s. The delay in attaining the original resistance, experienced both after illumination and after exposure to high voltages, is another evidence of the similarity of the two effects. E. E. F.

1873. *Photo-electricity of Phosphorescent Material.* **C. A. Butman.** (Amer. Journ. Sci. 34. pp. 133–139, Aug., 1912.)—Various phosphorescent materials, including Sidot blende ZnS, and calcium sulphide containing small additions of Na_2SO_4, $Na_2B_4O_7$, $CaFl_2$, and Bi (Lenard's CaBiNa), were ground to a fine powder with alcohol in an agate mortar and deposited on a plate of Pt or lead. The thinnest layers consisted of discrete particles. The results showed that photoelectric fatigue and recovery is an inherent property of the material and due solely to the incident light. High positive voltages applied to the brass case containing the phosphorescent plate accelerate the fatigue under illumination. The velocities of the electrons emitted were found to vary considerably. Sometimes the emission was spontaneous without an auxiliary field. But at other times as much as 4 volts had to be applied to get an effect. The highest observed p.d. necessary to prevent electrons from leaving CaBiNa was 0·85 volt. A complete saturation current would probably require 800 volts. No photoelectric effect can be obtained with CaBiNa with a wave-length longer than 410 $\mu\mu$. Sulphur is photoelectric with waves longer than 320 $\mu\mu$. It is also "actino-dielectric."

E. E. F.

1874. *Emission Velocities of Photo-electrons.* **A. L. Hughes.** (Roy. Soc., Phil. Trans. 212. pp. 205–226, Aug. 12, 1912.)—The author has measured the max. velocity of photo-electrons expelled from the surfaces of a number of elements prepared by distillation *in vacuo*. He shows that the energy of the fastest electrons emitted when monochromatic light falls on the surfaces is proportional to the frequency of the light. The velocity is not proportional to the frequency. The results are expressed in the form $V = kn - V_0$, where V is the velocity measured in volts, and n the frequency. The values of k and V_0 were found directly for the elements Ca, Mg, Cd, Zn, Pb, Sb, Bi, and As, and those for Se and oxygen indirectly. V_0 ranges from 2·57 volts in Ca to 4·5 volts in As (and 8·0 in oxygen), while k varies correspondingly from 3·17 to $3·7 \times 10^{-15}$. The values for elements of the same valency change regularly with the atomic volume. The product eV_0 is the work required to separate an electron from a molecule. The max. emission velocity of photo-electrons from a continually-forming Hg surface is identical with that from a surface of distilled Hg. The results are consistent with some form of quantum theory of emission.

E. E. F.

1875. *Photoelectric Effect in Salts.* **A. L. Hughes.** (Phil. Mag. 24. pp. 380–390, Sept., 1912.)—The salts studied were $ZnCl_2$, P_2O_5, PbI_2, HgI, HgI_2, HgCl, $HgCl_2$, $FeCl_3$, SbI_3, $BiCl_3$, as well as Ba and Cu oxides, and anthracene. Dry $ZnCl_2$ and P_2O_5 show no photoelectric effect. There is practically none in $FeCl_3$, and very little in PbI_2 after exposure to ultra-violet light. The other halogen salts show well-marked effects. The initial effect is either zero or very small for the halogen salts, but after exposure it increases in many cases to a large volume. It is suggested that there is no photoelectric action in the salts themselves, but that ultra-violet light decomposes the salts and then the metallic elements act in the usual way. The more stable the salt, the less is the effect. The photoelectric effect in anthracene is produced entirely by wave-lengths shorter than λ2002. The max. emission velocity corresponding to λ1849 is 0·87 volt. $ZnCl_2$ and P_2O_5 have no photoelectric effect when dry, but after contact with moist air they show a distinct effect. This effect cannot be accounted for by the photoelectric activity of water, which, if it exists, is much too small. [See Abstracts Nos. 1871 (1911); 558 (1912).]

E. E. F.

1876. *Magnetic Rays.* **L. T. More** and **E. G. Rieman.** (Phil. Mag. 24. pp. 307–316, Aug., 1912.)—Righi has applied the term "magnetic rays" to certain phenomena which occur when a magnetic current in rarefied air is influenced by a strong magnetic field. He has investigated the subject and concludes that the action of the magnetic field may give rise also to a new and special kind of rays [see Abstracts Nos. 952 (1908), 1084 (1909), 559 (1912)]. An abstract of his results and hypothesis to account for the phenomena observed is given. The apparatus employed in the present experiments is similar to that of Righi. The most important phenomena discovered by Righi when a magnetic field acts on the kathode rays in a tube containing air are repeated, and, in addition, it is found that the nature of the gas has an important influence on this action. While it is not possible to state exactly what these differences are and what their cause may be, yet the observations point to the conclusion that the magnetic rays are much more easily produced in air and artificial mixtures of nitrogen and oxygen than in the other mixtures tried; and they, in turn, are more sensitive to the influence of the field than simple gases, including the chemical compound CO_2. As regards what has been called the induced column, that is, the glow proceeding from the end of the magnetic rays which acts as if it were a current of charged ions moving in opposite directions from a virtual anode situated at a point in the column, it is only obtained in a well-developed form in air. While it is also observed with other mixtures containing nitrogen, the characteristic phenomena are less certain; in other mixtures and in simple gases it is absent. This seems to be correct, because if either pure nitrogen or oxygen were in the tube and a little of the other gas introduced, the induced column immediately declared itself. These results are difficult to account for by Righi's hypothesis. An attempt is being made to increase the discharge without unduly increasing the potential and to study the action of other gases and the state of the gas in different parts of the tube. A. E. G.

1877. *Ionomagnetic Rotations.* **A. Righi.** (R. Acad. Sci. d. Ist. di Bologna, Mem. 9. Ser. 6. 1911–1912. N. Cimento, 4. Ser. 6. pp. 49–109, July, 1912. Le Radium, 9. pp. 241–249, July, and pp. 289–300, Aug., 1912. Phys. Zeitschr. 13. pp. 755–767, Aug. 15, and pp. 873–890, Sept. 15, 1912.)—The author gives a more detailed and connected account of the emission of ions and electrons accompanying the production of magnetic rays [Abstract No. 409 (1912)]. He describes certain phenomena of the rotation of vanes in a vacuum which are only produced when the discharge is influenced by a strong magnetic field, and proposes to call such rotations "ionomagnetic rotations." E. E. F.

1878. *Spread of the Discharge from an Electrified Point.* **A. M. Tyndall.** (Phil. Mag. 24. pp. 424–432, Sept., 1912.)—Campbell has shown by the condensation method that negative ions are present during the positive discharge. The author has also found that there is an apparent increase—when the current increases—of the specific velocity of the ions in air, as measured by the wind-pressure method: this is readily explained by the back discharge. There is, further, definite evidence for the back discharge in exceedingly pure hydrogen [see Abstract No. 967 (1910)]. On the other hand, Zeleny concludes from some experiments on the rate of leak of a charged conductor placed in the discharge, that back discharge, if present, is exceedingly small in hydrogen and air at atmospheric pressure. Moore has shown [Abstract No. 910 (1912)] that calculating the velocity of the ions from the reaction at a discharging point, on the assumption of one-way discharge, values are obtained about five times greater than those generally accepted. The object of the present experiments is to test the hypothesis that there is in the discharge between a point and a plane at atmospheric pressure, a back discharge from the plate which is negligible in amount only for very small currents. A method of comparing the specific velocity of ions under different physical conditions, from the distribution of current over the plate in the point-plate discharge, is for this purpose tested for ions in air. The observed ratio of velocities of these ions at atmospheric pressure agrees with the accepted value. Owing, however, to the breakdown of assumptions as to the nature of the discharge, the method cannot be applied to lower pressures, and for the same reason has probably only a restricted application in general. In the light of these results the question of the presence of a discharge from the plate is discussed, with the conclusion that though certain facts strongly point to its presence, it is not necessary to the explanation of the phenomena observed. Certain special cases of discharge from the plate, met with in earlier work, are also investigated. A. E. G.

1879. *Oscillation and Hysteresis in the Glow Discharge.* **J. Herweg.** (Phys. Zeitschr. 13. pp. 633–641, July 15, 1912.)—The question is dealt with along the following lines :—Proof of the Kaufmann formula; the nature of the oscillation set up, and the cause of the hysteresis. With respect to the Kaufmann formula for which experimental proof is sought, it is concluded that it can only be explained by assuming a glow-discharge hysteresis. Two types of oscillation are considered, from the variations in the number of one of which some knowledge can be obtained as to the magnitude of the hysteresis. The hysteresis can be explained by the temperature-changes of the kathode and the consequent alteration in the density of the surrounding gas. A. E. G.

1880. *Disruptive Potential between a Wire and a Sphere.* **De Muynck.** (Annal. Soc. Sci. de Bruxelles, 36. 3–4. pp. 168–174, 1911–1912.)—Under the conditions of experiment it appears that the unipolarity between a wire and a sphere is very slight and notably inferior to that to be observed between a point and a plane. There appears, however, a very slight unipolarity by virtue of which the ratio $V+/V-$ will be superior to unity for very fine wires ($D = 0{\cdot}01$ and $0{\cdot}02$ cm.), while for larger wires ($D = 0{\cdot}05$ and $0{\cdot}09$ cm.) it will be less than unity. For values of the diam. $D = 0{\cdot}14$, $V+$ will be sensibly equal to $V-$. It is found that an elevation of the temperature of the wire causes a very pronounced unipolarity. A. E. G.

1881. *Current-potential Curves of the Oscillatory Spark.* **S. R. Milner.** (Engineering, 94. p. 549; with Discussion, Oct. 18, 1912. Paper read before the British Assoc. at Dundee.)—These curves are obtained by the aid of kathode rays as indicators, and are thus free from lag and inertia. Two induction coils are connected in series and actuated by the same mercury break : one of the coils charges a battery of jars and produces the spark, the other is simultaneously discharged through a vacuum tube giving the kathode rays. These rays are deflected in two directions, at right angles to each other, by the magnetic field of the spark current and by the electric field of the spark potential, a photographic plate being in direct contact with the fluorescent screen. Some photographs show the spark as a spiral light-band with a bright spot in the centre : when analysed this spiral gives the well-known potential- and current-time curves, with a lag of 90°. Under certain conditions the spiral band appears broken up by dark spaces as if dark striæ cross the whole photograph. This indicates that the potential rises in steps, and the oscillation periods can be calculated from the striæ. These observations confirm experiments made by Roschansky, and it is suggested that the oscillating discharge possessed a potential of 35 volts, characteristic of the arc, during the main part of each oscillation, which was combined with a glow discharge of about 300 volts. This glow only lasted a short period, and occurred when the current was changing sign. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1882. *The Influence of Pressure on the Position of Liquid Metals in the Thermoelectric Series.* **E. Siegel.** (Ann. d. Physik, 38. 3. pp. 588–636, June 18, 1912. Abstract of Inaug. Dissertation, Leipzig.)—The author has investigated the influence of hydrostatic pressure on the position of Hg and of liquid Bi and Sn in the thermoelectric series. A U-shaped glass capillary tube containing in its lower part the fluid metal was kept at a definite temperature. One side was raised by means of an electric oven to a temperature of about 50°. The bath consisted of heated Wood's metal, and, on account of the high conductivity, as great a constancy could be attained at 450° C. as is got at 100° with a vapour bath. The following results were obtained from the observations on the thermoelectric pressure effect:—(1) The effect in liquid Bi is in relation to the Wagner value for solid Bi of so small an order of magnitude (about 5 per mille) that perhaps both effects are of quite different nature. (2) Liquid Bi and Sn have pressure effects which at most are 2 % of the value for Hg, as has formerly been proved. (3) The value of the thermoelectric pressure effect for Hg was determined quantitatively within the limits of the earlier temperatures of observation, and it was besides established by observations up to 350°, that this effect is not a constant as hitherto assumed, but essentially depends on the temperature, in connection with which a proportionality of the effect with the thermo-e.m.f. (Hg-Cu) may be noticed. With regard to the earlier observations of Wagner the author's results show that "structure effects" exist both at the places of passage from a thin to a strong wire and in homogeneous hard wires where a fall in temperature occurs. J. J. S.

1883. *Constancy of Wire Resistance Standards.* **F. Wenner.** (Washington Acad. Sci., Journ. 2. pp. 414–418, Oct. 19, 1912.)—Indicates the probable changes in resistance over a period of 2¼ years of 10 one-ohm sealed resistance standards of manganin and nine 10,000-ohm sealed standards of the same alloy. Tables which are given show that during 2¼ years the resistance of only one of the unit coils changed by more than 0·002 per cent., and that the average change of these coils was less than 0·001 per cent. With regard to the 10,000-ohm standards only one changed in resistance by as much as 0·005 per cent. Some new standards are being made with a resistance material known as "therlo," and there are indications that this alloy will be found fully as reliable as manganin. F. E. S.

1884. *Photoelectric Photometer.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 13. pp. 739–744, Aug. 15, 1912.)—Recommends the adoption of the potassium photoelectric cell as an electric photometer. The potassium is further sensitised by the glow discharge in hydrogen, and placed in an argon or helium atmosphere. Describes such a photometer designed for measuring sunlight and daylight, but suitable also for measuring down to a few thousandths of a Hefner candle. The instrument resembles a small gun, the barrel being a tube provided with an iris diaphragm, and with a screen of ground uviol glass at the inner end, intended to eliminate the selective photoelectric effect which appears at slanting incidence. Suitable light-filters are attached to the outer end of the tube. The photometer is mounted like a theodolite. A dry battery of some 40 volts and a galvanometer giving 1 div. per microamp. complete the field equipment. For faint light, an electrometer must be employed, and its time of discharge noted. Currents down to 10^{-13} amp. may thus be measured; 0·001 candle-metre would give a current of 10^{-14} or 10^{-15} ampere. E. E. F.

1885. *Expansion Apparatus for making Visible the Tracks of Ionising Particles in Gases: Results obtained.* **C. T. R. Wilson.** (Roy. Soc., Proc. Ser. A. 87. pp. 277–292, Sept. 19, 1912.)—In a previous paper [Abstract No. 1544 (1911)] experiments were described in which the author had succeeded in making visible the tracks of α-particles through a moist gas by condensing water on the ions immediately after their formation. The expansion apparatus and the method of illuminating the clouds have both been improved in detail, and it has now been found possible to photograph the tracks of even the fastest β-particles, the individual ions being rendered visible. For the numerous details the original paper must be consulted: 19 photographs are reproduced in the paper, showing the results of the experiments. The tracks of the α-particles are generally straight over the greater part of their length, but they are nearly all bent, often abruptly, in the last 2 mm. of their course. Abrupt bends through considerable angles are seen much earlier in the course of some of the particles. Apart from these sudden bends a certain amount of curvative is apparent in some of the tracks. The photographs thus furnish evidence of two distinct ways in which α-particles are "scattered" in passing through air, what Rutherford [Abstract No. 1847 (1911)] has called "single" and "compound" scattering respectively. The complete tracks of α-particles from RaEm inside the expansion chamber show an enlarged "head" at the beginning of the track. This probably represents ionisation by the recoil of the atom from which the α-particle has escaped.

With β-particles the photographs of the tracks show the individual ions produced in pairs, with here and there groups of 20 to 30 closely packed. The occurrence of the groups or clusters of ions may be interpreted as indicating that in certain cases the corpuscle liberated from an atom by a high-velocity β-particle may itself have energy enough to ionise for a very short distance. β-rays of small velocity give tracks much more readily deviated and with much more ionisation per cm. The scattering of the β-rays appears to be mainly or entirely of the cumulative or "compound" type, being due to a large number of successive deflections each in itself inappreciable.

The following are the chief characteristics of the photographs with a narrow beam of X-rays. (1) Kathode or β-rays are seen to start from within the track of the primary X-ray beam, many of them extending to some distance outside it. (2) There is no indication of any effect of the X-rays other than the production of the secondary kathodic radiation, thus supporting Bragg's view that X-rays of themselves do not ionise. (3) The total length of the track of the secondary kathode rays was, for the particular X-rays used, on the average a little less than 1 cm. when reduced to atmospheric pressure. (4) The kathode rays appear to start in all directions, although the author has as yet not made a systematic statistical study of this question. E. M.

1886. *Contact E.M.F.* **G. Guglielmo.** (N. Cimento, 4. Ser. 6. pp. 181–188, Aug., 1912.)—Devises some further arrangements whereby the e.m.f. of a cell may be calculated without bringing the two electrodes into direct contact [see Abstracts Nos. 967, 1131 (1912)]. Determines how far the thermodynamic reasoning of Kelvin and Helmholtz is applicable to such cells. E. E. F.

ALTERNATING CURRENTS AND MAGNETISM.

1887. *Magnetic Hysteresis.* **E. Marini.** (N. Cimento, 4. Ser. 6. pp. 155–171, Aug., 1912.)—The author criticises the deductions from Duhem's equations by which Cisotti arrives at his theory that the state of magnetisation of a body depends only on two positive constants [Abstract No. 2024 (1908)]. Experiments on the hysteresis of iron and steel with a coercive force ranging from 2·1 to 61·7 and the residual magnetism from 0·05 to 85·61, show that the results calculated by means of the theory are only true within very narrow limits of magnetisation. W. H. Si.

1888. *Moment of Inertia of a Magnet.* **R. L. Faris.** (Terrestrial Magnetism, 17. pp. 156–158, Sept., 1912.)—The author, when experimenting with a long magnet of the magnetometer of the Cheltenham Magnetic Observatory, found a measurable difference between the values of the moment of inertia of the magnet as computed from its dimensions and mass, and as determined experimentally with the aid of an auxiliary inertia weight. It was thought that the difference must be due to magnetic impurities in the brass magnetometer house or to damping effects. Observations made with special wooden and non-magnetic casings show that this hypothesis is incorrect and the anomaly remains unexplained. A. D. R.

1889. *Self-demagnetisation of Annealed Steel Rods.* **S. W. J. Smith** and **J. Guild.** (Phys. Soc., Proc. 24. pp. 342–349; Discussion, p. 349, Aug., 1912.)—Seven annealed steel rods, each 7 cm. long and 0·55 cm. in diam., containing about 0·2 % Mn, about 0·1 % Si, and C ranging in six from 0·36 to 1·58 %, and in the seventh being 0·15 %, were magnetised as nearly as possible to saturation, and after gradually withdrawing the field the residual magnetism was measured. In all cases this was positive, but on heating the rods it gradually fell to zero and then became negative, except with the sample containing only 0·15 % C, for which the residual magnetism never fell below zero. The transition from positive to negative polarity takes place between 180° and 200° C., the negative magnetism reaching a maximum at about 220° and then gradually diminishing as the temperature is raised until at 700–750° it again becomes zero. The amount of negative magnetism is greatest for a steel containing 0·85 % C, which represents a saturated or eutectoid steel, and the phenomenon is attributed to the effect of the presence of iron carbide, the magnetisation of which gradually diminishes as the temperature is raised to 230°, and above this point becomes very small, so that any variation in residual magnetism is mainly due to iron.

After heating the rods to 800°, no polarity becomes perceptible on cooling, but if the heating is interrupted before the whole of the residual magnetism is destroyed, the negative polarity first increases on cooling, becomes zero at about 210°, and a slight positive magnetisation is then developed as the temperature falls to that of the atmosphere. W. H. Si.

1890. *Measurement of the Absolute Susceptibility of Liquids.* **W. J. de Haas** and **P. Drapier**. (Deutsch. Phys. Gesell., Verh. 14. 15. pp. 761–763, Aug. 15, 1912.)—A modification is employed of the Quet-Quincke method of using the capillary rise in a narrow tube. This modification is a hydrostatic null method, so that one works with a plane meniscus. The value $\kappa = 0{\cdot}78 \times 10^{-6}$ was obtained with a field of about 31 kilogauss at temperature 24° C. A. D. R.

1891. *Permanent Magnetism of Volcanic Bombs.* **S. Nakamura** and **S. Kikuchi**. (Mathematico-Physical Soc., Tōkyō, Proc. 6. 18. pp. 268–273, July, 1912.)—Experiments were carried out on six volcanic bombs each of the same spindle-like shape and with the ends slightly curved. The intensity of residual magnetisation is almost the same for each, viz., about 0·02 c.g.s. unit. The magnetic axis coincides neither with the major nor with the minor axis of the specimens, and the north pole is always on the flatter side. From this fact the authors conclude that when the bomb was formed on the volcano the flatter side was downwards, unless the direction of the earth's field was opposite to that at present. A. D. R.

1892. *Wireless Telegraphy and Terrestrial Magnetism.* **C. Chree**. (Nature, 90. p. 37, Sept. 12, 1912.)—The paper of Eccles [see Abstract No. 1254B (1912)] suggests that several of the phenomena of the propagation of electric waves round the earth are largely influenced by an ionised layer in the atmosphere. The hypothesis is analogous to that made to explain the phenomena exhibited by the diurnal variation of the magnetic elements. This variation is generally regarded as most probably due to electric currents in the upper atmosphere, and it has been suggested that the normally larger magnetic changes by day as compared with those at night are caused by an increased ionisation of the atmosphere due to sunshine. Regular diurnal magnetic variations are much larger in years of many than of few sun-spots. The variation is also much larger in high latitudes. It has recently been found that a large part of the magnetic sun-spot relationship may be explained by a direct connection between the amplitude of the diurnal magnetic range and the spotted area of the sun some four days previously. The object of the note is to direct the attention of those in control of wireless stations to the field of research thus suggested. Wireless telegraphy may lend itself to the direct experimental investigation of the causes of many of the phenomena of terrestrial magnetism. H. H. H.

1893. *Origin of Terrestrial Magnetism.* **L. A. Bauer**. (Terrestrial Magnetism, 17. pp. 115–140, Sept., 1912.)—This paper is a continuation of previous work [see Abstract No. 1449 (1912)]. Confining attention to the portion of the earth's magnetic field which is symmetrical about both the axis of rotation and the equator, the author arrives at the following results :—(1) If the intensity of magnetisation be computed separately for each parallel over the region best covered by magnetic observations, 60° N. to 60° S., on the basis that the average values of the magnetic components along a parallel correspond to those of a uniform magnetisation parallel to the axis of rotation, then a systematic increase in the intensity of magnetisation is observed in both hemispheres in going from parallel to parallel towards the equator. Thus, for example, for the mean of parallels 60° N. and S., this constant in c.g.s. units is found to be 0·070, whereas for the equator it is 0·082—an increase of 17 per cent. This fact, when mathematically expressed, furnishes a criterion for testing the sufficiency of the theories to account for the origin of the earth's magnetism. No theory so far advanced meets the requirements. (2) The portion of the earth's magnetic field considered is similar to that of a uniformly magnetised sphere which has superposed on it another field whose intensity in both hemispheres increases systematically from parallel to parallel, with approach towards the equator. A physical expression is found, consisting of the zonal harmonics of the first and third order, which gives a representation of the observed facts to within 1 per cent. A. D. R.

1894. *Theory of Prismatic Pole-pieces.* **H. du Bois.** (Deutsch. Phys. Gesell., Verh. 14. 15. pp. 758–760, Aug. 15, 1912.)—The paper discusses the intensity and uniformity of field which can be obtained between the poles of an electromagnet fitted with prismatic pole-pieces, and figures are given of the actual results obtained with a Du Bois half-ring electromagnet. A. D. R.

1895. *Lunar Variation of Terrestrial Magnetism.* **W. van Bemmelen.** (Meteorolog. Zeitschr. 29. pp. 218–230, May, 1912.)—Analysis is made of the magnetic variation at fourteen stations, the effects being separated into solar and lunar portions for each hemisphere. C. P. B.

RADIOLOGY AND ELECTROPHYSIOLOGY.

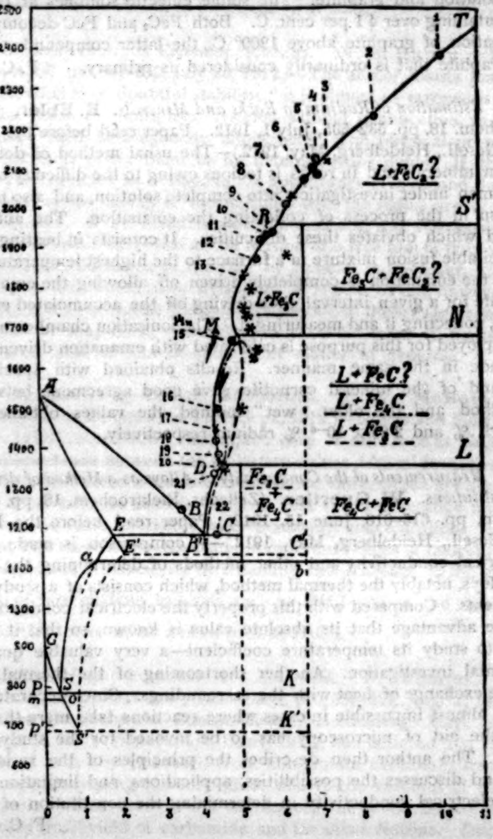
1896. *Radiophotoscope: Apparatus for Comparing Röntgen-ray Doses.* **T. Nogier.** (Archives d'Él. Médicale, 20. pp. 346–353, Oct. 10, 1912.)—The practical apparatus for measuring Röntgen-ray doses, such as the radiometer of Sabouraud and the chromo-radiometers of Bordier and Holtzknecht are based upon changes in the barium platinocyanide. A comparison has to be made of the tint of the platinocyanide with that of a coloured scale. This means that a more or less fluorescent substance has to be compared with a coloured object which is non-fluorescent. Such comparisons are found to vary very much according to the light in which they are made, so much so that it seems that daylight comparisons must be discountenanced altogether. In the present apparatus, which is of a simple nature, one great advantage is that comparisons can be made at any time afterwards by means of artificial light. Small Röntgen-ray doses can be very exactly determined because the yellow light used increases the sensitivity threefold. It is also possible in the case of weak doses to obtain two mutually controlling readings. Lastly, a prolonged comparison of the pastille with the scale can be made without fear of the former changing, since the light of the incandescent lamp used to examine it, being free from ultra-violet rays, is without action upon it. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1897. *Active Modification of Nitrogen produced by the Electric Discharge.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 87. pp. 179–188, Aug. 21, 1912.)—Some previous observations [see Abstracts No. 596, 1119 (1912)] seemed to suggest that the chemical peculiarities of active nitrogen might not be due to the presence of a definite chemical substance, but to the unexplained survival of the conditions of disruptive discharge. Further experiments support the former view, however. When the active nitrogen is passed through a vacuum-jacketed tube containing a roll of oxidised copper gauze, the gauze becomes heated by the reversion of the active to ordinary nitrogen, particularly when nitric oxide is mixed with the nitrogen, while the temperature goes down when oxygen is admitted instead of NO. Ionisation experiments show that the intensity of the glow is not affected by the removal of the ions, and can hardly be produced therefore by ions. Local cooling intensifies the glow by making the change more rapid; this is proved by dipping a bulb with its tubular neck into liquid air. The active nitrogen hence appears to be a highly endothermic body, the energy of which, however, is of the same order of magnitude as that of other chemical substances. The ionisation is a subordinate effect, and might be due to light of very short wave-length emitted during the reversion to ordinary nitrogen: the number of the ionised atoms is a very small fraction of the whole number of atoms concerned in the change. It is suggested that the active nitrogen is monatomic, and that the phenomena may throw light on the connection between temperature and velocity of reaction. H. B.

1898. *Allotropism and Directed Valency.* **F. B. Guthrie.** (Roy. Soc., N. S. Wales, Journ. and Proc. 45. 3. pp. 318–336, Sept.–Dec., 1912.)—Applies J. J. Thomson's corpuscular theory of valency to the case of allotropic states. Valency is supposed to be due to the transference of electrons from one atom to another. Such transference produces "a unit tube of electric force between the two atoms, the tube starting from the positive and ending on the negative atom." Thus methane is formed by an electron being expelled from each of the four hydrogen atoms and being embodied in the carbon atom. The "bonds" are represented by arrows representing the direction of the transfer. Allotropic forms are, on this view, due to the different ways in which this transfer can be effected in the same molecule. In the sexavalent sulphur molecule there are only four ways which are both stable and symmetrical. Arranging the atoms in a ring the electrons can travel (1) in the same direction; (2) in alternately opposite directions; (3) two in the same direction, and the next two in the opposite direction; or (4) four in one direction, and the other four in the opposite direction; always taking the atoms successively round the ring. The author attributes each of these figures to one of the known allotropes of sulphur, and also deals with Se, Te, As, and P. E. E. F.

1899. *Researches on Iron-Carbon Alloys.* **Wittorf.** (Rev. de Métallurgie, 9. pp. 600–617, Aug., 1912.)—Moissan found that on fusing pure iron in the presence of sugar-carbon the fluidity decreased with increasing temperature until at about the melting-point of titanium the metal was quite viscous but regained its fluidity on cooling. The author attributes these phenomena to the existence of an endothermic compound, and, recognising their importance, not only from a theoretical point of view but also from the standpoint of modern electrometallurgy, has undertaken a complete investigation of the hypereutectic alloys of iron and carbon up to 24 per cent. C, with the aid of an electric arc furnace. The results of thermal examination have been confirmed by micrographic analysis and are summed up in the accompanying diagram. Along the line TR the liquid alloys deposit well-developed crystals of FeC_2 which are magnetic and somewhat more readily attacked than cementite by dilute nitric acid. Cementite is deposited primarily along the line RM, and the field MNLD is marked by a liquefaction of the already solidified alloys on cooling, especially noticeable in materials con-



taining about 7 per cent. C. The max. liquefying effect is observed at about 1870° C. Stirring during this period causes the flotation of thin plates of FeC, which are also deposited primarily along MD. Along the line DL the compound Fe_4C is formed, and it can be seen as a metallic-looking phase surrounding the FeC or FeC_2 crystals in alloys quenched just below 1700° C. It is strongly attacked by dilute nitric acid, and at 1180° C. decomposes into γ solid solution and graphite. The stable eutectic solidifies at 1180° C. in alloys containing over 4·1 per cent. C. Both FeC_2 and FeC decompose with the formation of graphite above 1200° C., the latter compound giving rise to the graphite that is ordinarily considered as primary. F. C. A. H. L.

1900. *Estimation of Radium in Rocks and Minerals.* **E. Ebler.** (Zeitschr. Elektrochem. 18. pp. 532–535, July 1, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—The usual method of determining radium in minerals and in rocks is tedious owing to the difficulty of getting the specimen under investigation into complete solution, and also to loss by absorption in the process of collecting the emanation. The author uses a method which obviates these difficulties. It consists in heating the rock with a suitable fusion mixture in a furnace to the highest temperature it can stand till the emanation is completely driven off, allowing the emanation to accumulate for a given interval, then driving off the accumulated emanation as before, collecting it and measuring it. The ionisation chamber or electroscope employed for this purpose is calibrated with emanation driven off from pitchblende in the same manner. Results obtained with specimens of granite and of the mineral carnotite gave good agreement between the new method and the older "wet" method, the values obtained being $8·8 \times 10^{-10}$ % and $2·85 \times 10^{-6}$ % radium respectively. E. M.

1901. *Measurements of the Conductivity of Alloys as a Method of determining their Constitutions.* **W. Guertler.** (Zeitschr. Elektrochem. 18. pp. 601–615; Discussion, pp. 615–616, June 15, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—A comparison is made between the electrical conductivity and other methods of determining the constitution of alloys, notably the thermal method, which consists of a study of their heat-contents. Compared with this property the electrical conductivity possesses the advantage that its absolute value is known, so that it becomes possible to study its temperature coefficient—a very valuable quantity in experimental investigation. Another shortcoming of the thermal method lies in the exchange of heat with the surroundings. Since accurate control of this is almost impossible in cases where reactions take more than a few seconds the aid of microscopy has to be invoked for the study of slow reactions. The author then describes the principles of the resistometric method and discusses the possibilities, applications, and limitations of the study of electrical conductivity in determining the constitution of alloys.
F. C. A. H. L.

1902. *Densities of the Co-existing Phases of Sulphur Dioxide near the Critical Point.* **E. Cardoso.** (Archives des Sciences, 34. pp. 127–140, Aug., 1912.)—The method employed by the author consisted in determining at a given temperature the volumes of the liquid and gaseous phases of two known quantities of the substance contained in Natterer tubes of special construction. If P is the quantity of substance in one of the tubes, D and V the density and volume of the liquid phase and *d* and *v* the weight and volume of the gaseous phase, while P_1, V_1 and v_1 represent respectively the quantity of substance and the volumes of the two phases in the other tube, then: $d = (VP_1 - V_1P)/(v_1 V - vV_1)$ and $D = (v_1P - vP_1)/(v_1V - vV_1)$. The two tubes were immersed at the same time in a bath of the Ramsay-Young type containing dibromobenzene boiling under a pressure which could be regulated. The results obtained have already been published [see Abstract No. 1742 (1911)]. The anomalies in the neighbourhood of the critical point are discussed in their relation to the equation of state. T. H. P.

1903. *General Theory of Colloidal Solutions.* **W. B. Hardy.** (Roy. Soc., Proc. Ser. A. 86. pp. 601–610, July 20, 1912.)—The author insists that, since a colloidal solution is of doubtful stability, "it is almost as erroneous to speak of colloidal fluids as multiphase systems without qualification, as it would be to ignore their heterogeneity altogether." The physical properties of colloidal solutions prove them to be heterogeneous fluids. If the colloid particles are regarded as a stage in the appearance of a second fluid phase, the variations of the energy of the particles with the radius are of predominant importance. If we could assume, for instance, that the tension of the interface varied with the radius as the tension of a free film of fluid was found to vary with the thickness of the film by Renold and Rücker, globules of certain dimensions would alone be stable. It is pointed out, however, that at present there is no adequate basis in experiment or theory for regarding the peculiarities of soap-films, themselves a colloidal form of matter, as the properties of films or minute spheres of matter in general. T. M. L.

1904. *Dissociation of Ternary Electrolytes.* **J. W. McBain.** (Amer. Chem. Soc., Journ. 34. pp. 1134–1137, Sept., 1912.)—Noyes and Falk [Abstract No. 1129 (1912)] have shown that in the case of salts such as $BaCl_2$ there is striking discordance between the ionisation-values derived from the freezing-point and those derived from the conductance ratio, which are always much smaller; these salts are also abnormal in that the transference numbers for the kathions decrease markedly with increasing concentration. The author points out that these anomalies occur in different ranges of concentration and may be explained satisfactorily by assuming the existence in the more dilute solutions of intermediate kathions such as $\overset{+}{BaCl}$ and in the more concentrated solutions of complex anions such as $\overset{-}{BaCl_3}$. T. M. L.

1905. *Electrolytic Oxidation of Ammonia.* **F. Fichter.** (Zeitschr. Elektrochem. 18. pp. 647–653; Discussion, pp. 653–654, Aug. 1, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—The author and K. Stutz (Dissertation, Basel, 1911), had believed that the electro-synthesis of urea (by Drechsel) from ammonium carbonate was a direct-current (not alternating-current) effect due to the reaction of nascent CO_2 on ammonia. This view is not satisfactory, however, on account of the mostly very small yield of carbamide and for other reasons. Discussing the literature on the subject and new experiments the author now suggests that in the oxidation of organic compounds in ammonia those compounds yield carbamide which give formamide as intermediate product. The oxidation of ammonia may be assumed to proceed by the stages $NH_3 \longrightarrow NH_2.OH \longrightarrow H_2N_2O_2 \longrightarrow HNO_2 \longrightarrow HNO_3$; the two last products have been found, but there is no direct evidence for the formation of hydroxylamine and of hyponitrous acid by the electrolytic oxidation. Nearly 80 per cent. of the coulombs remain unaccounted for, however, and nitrous oxide would appear to escape; that would indicate a formation of hyponitrous acid; but the formation of hydroxylamine cannot be demonstrated, and the attempted electrolytic reduction of hydroxylamine to formamide did not lead to definite results. Carbamide was, however, obtained by the electrolytic oxidation of ammonium formate in aqueous and in liquid ammonia and also by the electrolytic oxidation of ammonium acetate. In the presence of ethyl-alcohol the electrolysis of ammonium carbonate yielded acetamidine nitrate. The *discussion* by **W. Nernst, Erich Müller, G. Bredig,** and **C. Schall** concerned the difficult determinations of the products in the complex reactions. H. B.

1906. *Preparation of Ferrous Chloride by the Electrolysis of an Ethereal Solution of Ferric Chloride.* **H. E. Williams.** (Amer. Chem. Soc., Journ. 34. pp. 1014–1016, Aug., 1912.)—The electrolysis of concentrated ethereal solutions of ferric chloride, using a high current density, gives metallic iron and hydrogen at the kathode, and a few bubbles of gas, probably oxygen, at the anode. Dilute solutions give ferrous chloride at the kathode when a low current density is employed; no chlorine or other gas is evolved, but hydrochloric acid accumulates in the solution as the electrolysis continues. The author assumes the formation of monochloroethyl ether as an intermediate product in order to explain the results obtained. T. S. P.

1907. *Reduction of Potassium Dichromate in Solution by Alternating Currents.* **P. Wenger** and **D. Midhat.** (Ann. Chim. Anal. 17. pp. 321–323, 1912.)—The reduction of potassium dichromate in dilute sulphuric acid solution (2 c.cm. of N/1 acid per 200 c.cm. of solution) by alternating current (110 volts, 2·5 amps.) is dependent on the time of action when Pt electrodes are employed; with rotating electrodes, 100 % of the dichromate is reduced in 105 min., whilst in the same time only 51·6 % is reduced when stationary electrodes are used. The reduction depends also on the kind of electrode, the following proportions of the quantity of salt present being reduced in one hour by different rotating electrodes: Copper, 95·4 %; aluminium, 7·3 %; lead, 76·4 %; nickel, 45·8 %; silver, 95·4 %; platinum, 66·8%. In the case of aluminium and lead the reduction proceeded more rapidly when the electrodes were stationary. L. H. W.

1908. *Reduction of Potassium Permanganate Solutions by Alternating Current.* **G. Wenger** and **H. H. Alvarez.** (Ann. Chim. Anal. 17. pp. 202–204, 1912.)—The authors have made a number of experiments on the reduction of acid solutions of potassium permanganate, and the results have been tabulated. They have arrived at the following conclusions: (1) The reduction is strongest with rotating electrodes whatever may be their nature. (2) Copper electrodes reduce the solution the most rapidly, whilst aluminium only effects a partial decomposition in twice the time. (3) The phenomenon is more pronounced at the beginning than at the end of the experiment. (4) The reduction due to the sole action of the metal is almost negligible with Pt electrodes. L. H. W.

1909. *Electrolytic Estimation of Molybdenum.* **A. Fischer** and **J. Weise.** (Zeitsch. Anal. Chem. 51. pp. 537–550, 1912.)—In order to accelerate the electrolysis, a small quantity of sulphuric acid has hitherto been employed, but the authors have substituted for this hydrochloric acid (0·25 c.cm. of fuming acid to 120 c.cm. of liquid). The molybdenum sesquioxide deposited may be converted into molybdenum trioxide, without the use of nitric acid, by simply heating for some time at 400° by means of an electric arrangement. L. H. W.

1910. *Stability of Argon and Helium in Solid and Liquid Metals.* **A. Sieverts** and **E. Bergner.** (Ber. Deut. Chem. Gesell. 45. pp. 2576–2583, 1912.)—Argon and helium do not show a measurable solubility in either solid or liquid copper, silver, gold, nickel, iron, palladium, aluminium, magnesium, uranium, or tantalum. At 1100° powdered quartz glass (6·7 gm.) absorbs 0·1 c.cm. of helium or of hydrogen—a fact which is in accordance with the diffusion of these gases through quartz at this temperature. The connection between the temperature and the amount of helium evolved from cleveite was investigated, and it was found that the best results are obtained by direct heating of the mineral at 1000–1200° in a porcelain tube. At high temperatures porcelain is much less permeable to helium than quartz glass. It is probable that uranium dissolves hydrogen, 100 gm. of the metal absorbing 1·6 mgm. of hydrogen at 1100° and 760 mm. T. S. P.

1911. *Action of Some Elements on Fused Potassium Hydroxide.* II. **M. Le Blanc** and **O. Weyl.** (Ber. Deut. Chem. Gesell. 45. pp. 2300–2315, 1912.) —The arrangement previously described [Ibid. 42. p. 4728, 1909], has been improved by substituting an electric oven for the gas oven used to heat the fusions. Potassium hydroxide can be obtained in the anhydrous condition by heating at 400°; even at 660° there is no appreciable dissociation into K_2O and H_2O, but vaporisation takes place to some extent. The gold crucible was attacked to some extent, although not chemically; a nickel crucible is attacked with formation of nickel hydroxide. Contrary to the usually accepted statement, potassium does not act on potassium hydroxide at temperatures up to 555°. By the action of potassium on sodium hydroxide and of sodium on potassium hydroxide at 550–660°, it is probable that the equilibrium $Na+KOH \rightleftharpoons K+NaOH$ is set up; superposed on this is the reaction $Na+NaOH=H+Na_2O$ and vaporisation of the potassium. At temperatures between 550° and 660°, gold, aluminium, and manganese have no, or at all events an extremely small, action on potassium hydroxide in an atmosphere of nitrogen. Iron, cobalt, and nickel are appreciably attacked, without, however, it being possible to prove the formation of water, hydrogen, or potassium. The reaction with chromium, molybdenum, and tungsten is also very slight, but the formation of potassium and hydrogen can be proved. Carbon and magnesium are readily attacked, potassium and hydrogen being formed, whilst with silicon the reaction proceeds violently at 400°, hydrogen alone being formed. The reactions taking place with magnesium can be formulated as follows:—

$$Mg+2KOH=Mg(OH)_2+2K;\quad Mg(OH)_2=MgO+H_2O;\quad H_2O+K=KOH+H.$$

Similar equations can be written to represent the action on chromium, molybdenum, tungsten, and carbon. T. S. P.

1912. *A Constant Form of Galvanic Element with Carbon Anode.* **F. Fischer** and **R. Lepsius.** (Ber. Deut. Chem. Gesell. 45. pp. 2316–2317, 1912.)—The element consists of fused sodium hydroxide contained in a nickel or iron crucible, the one electrode being a carbon rod, the other a rod of fused ferrosoferric oxide as made by the Fabrik Griesheim-Elektron. The voltages, on open circuit, are 0·6, 0·7, and 0·8 volt at 350°, 450° and 550° respectively. When closed through a resistance of 10 ohms the voltage falls to 0·6 volt at 550°, the current strength being 60 milliamps. and remaining constant for hours. The constancy of the e.m.f. thus obtained distinguishes the cell from others. By blowing air on to the iron oxide electrode, the depolarising action is somewhat improved. T. S. P.

1913. *Nature of Helium.* **F. H. Loring.** (Chem. News, 106. p. 37, July 26, 1912.)—Reasons based upon the periodicity of the elements are given for regarding helium as essentially an electro-positive element. E. E. F.

1914. *Electrical Endosmose.* **W. D. Bancroft.** (Journ. Phys. Chem. 16. pp. 312–317, April, 1912.)—By the use of certain assumptions with respect to the extent of the adsorption of ions or of undissociated molecules by a diaphragm the author is enabled to explain a number of phenomena met with in the study of electrical endosmose and of various electrolytic processes.

T. S. P.

1915. *Applications of the Law of the Rectilinear Diameter.* **H. Davies.** (Phil. Mag. 24. pp. 415–424, Sept., 1912.)

1916. *Chemical and Mechanical Relations of Iron, Vanadium, and Carbon.* **J. O. Arnold** and **A. A. Read.** (Iron and Steel Inst., Journ. 85. pp. 215–227; Discussion and Correspondence, pp. 227–234, 1912. Engineering, 93. pp. 784–786, June 7, 1912.)